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Centenary of the Patent Office

ONE hundred years ago this month the Patent Office was opened on its present site at 25, Southampton Buildings, London, W.C.2, and to mark the occasion of its centenary an interesting exhibition, dealing with the background, history, work, and facilities of this important establishment, has been arranged in the office library. Up to the time this office was opened the granting of patents involved a complicated, tedious procedure, which included visits to seven different offices and the payment of fees totalling about £100 for a patent in England alone. To take out a patent covering the United Kingdom necessitated visits to some sixteen offices and the payment of more than £300. Each application had to pass through ten separate stages, at two of which the personal signature of the Sovereign was required. It was under the Patent Law Amendment Act of 1852 that the initial fees for obtaining a patent in the United Kingdom were reduced to £25, and the granting of patents was placed in the hands of Commissioners. Although procedure was considerably simplified, difficulties and complications were experienced up till a new Patent Act was passed in 1883, when the responsibility for the issuing of patents was transferred to the Board of Trade. The Patent Office as we now know it was then placed under the control of a Comptroller General and the task of examining patents fell to a staff of scientific officers. In succeeding years various alterations and extensions were made in the organisation and work of the Patent Office to bring it up to the very high standard for which it is so well known to-day. The exhibition in the library is well worth visiting. It includes examples of some of the earliest known patents, amongst which is that granted in 1449 to Utynam for glazing of the King's Chapels. Copies of a hundred patents of industrial historical note can be examined, and arranged nearby in contrast is a group of fifty curious, unusual and amusing patents. Other exhibits include collections of Patent Office and Patent Agents circulars, pamphlets, &c., trade marks, and many documents and books of interest.

Resignation of Lord Nuffield

AT the first annual meeting of the British Motor Corporation at Cowley, on Wednesday, December 17th, Lord Nuffield announced his resignation from the posts of chairman and director of the Corporation and of Morris Motors Ltd., and its associated companies. He is to be succeeded by Mr. Leonard P. Lord, who is at present the chairman and managing director of the Austin Motor Company and deputy chairman and managing director of the Corporation. In announcing his resignation, Lord Nuffield said that he had reached his seventy-sixth year and he had been at the helm for nearly sixty years. Although his health was good, he considered that it now seemed an appropriate time to hand over his business responsibilities to a younger generation. In his capacity of honorary president of the British Motor Corporation, however, his advice and experience would always be available. Lord Nuffield's industrial career began in 1892, when he opened a bicycle repair business at Cowley, near Oxford. From repairing bicycles he went on to deal with motor-cycles, and eventually, in 1912, he entered the motor-car industry, when he assembled his first motor-car by hand. After the first world war the growth of Morris Motors was very rapid under the guidance of Mr. Morris, who was created a baronet in 1929, a baron in 1934 and a viscount in 1938. Before the outbreak of the second world war Lord Nuffield had acquired a number of other old-established firms in the British motor industry and he continued production under their well-known names as well as manufacturing his own vehicles.

Road Research

THE annual report of the Road Research Board and the Director of Road Research, D.S.I.R., for 1951 has now been published. Many points of importance are brought out in the report. An estimate is given of the expenditure on transport in Great Britain, showing that 10 per cent of the community's expenditure on goods and services of all kinds was spent on road transport. Furthermore, the expenditure on road transport was 75 per cent of the expenditure on all forms of internal transport and travel. The Road Research Board points out that these figures clearly indicate the importance of the roads in the nation's economy. An investigation of the cost of traffic delays has been started. It is well known that in the big cities traffic congestion causes delays which are very costly to the community. It is part of the Laboratory's work to find out how the value of road improvement schemes can be assessed in relation to the monetary saving to the nation that will result from them. In October, 1951, a Press Conference was held to make public the results of an investigation on rear lights. If the recommendations then made (twin rear lights on cars and lorries and all rear lights, including those on bicycles, to be not less than 0·25 candle power) were generally adopted, it was estimated that a reduction in casualties of more than 3000 a year should result. Mention is made of an important investigation carried out by the Army Operational Research Group. It was found that a red warning light operated by the foot brake reduced by nearly 0·7 second the average time taken by the driver of a following vehicle to realise that the vehicle in front was slowing down. An additional warning time of 0·3 second, making 1·0 second in all, could be gained if the stop light was operated by the accelerator pedal instead, of the brake. At present there is special need for the greatest economy in materials and labour in road making. The traditional tendency in designing the road crust has been to err on the safe side in deciding upon the thickness of crust. Experiments are in progress to find out precise data relating thickness to road performance. Such data will enable the performance of any design of pavement to be decided before construction starts, thereby effecting savings in money and materials. One experiment is on the Oxton by-pass near Nottingham. Different thicknesses of concrete, reinforced and not reinforced, were used in the construction of this road. Useful results are now being yielded. For instance, the value of reinforcing the slabs is now becoming clear. All the reinforced slabs, even those only 3in thick, were, although cracked, still satisfactorily carrying the traffic. No unreinforced slab less than 5in thick has proved satisfactory on that soil.

Training of Latin-American Engineers

IN his inaugural address as the new president of the British Association for Commercial and Industrial Education last week, Sir Arthur Fleming discussed technical aid to the Latin-American countries. He referred to his visit with a special mission sponsored by the Federation of British Industries and supported by the Board of Trade to investigate what help Great Britain could give Latin-America in the development of its industry and trade. One of the more important fields in which this country could aid the Latin-American countries, he considered, was in the education and practical training of their young engineers. Sir Arthur pointed out that for many years progressive engineering firms have received into their organisations young engineering graduates from overseas universities and provided for them practical engineering training. After their return home these men have soon attained positions of responsibility often involving the purchase of new plant and equipment, for which they have naturally turned to Great Britain. This practice had given great stimulus to export trade, and in the past trainees had mostly come from the Commonwealth. There were, however, many other countries where it could be followed to advantage, notably in Latin-America. From a recent investigation of this problem of the training of young engineers carried out in nine of the Latin-American countries it was clear that in the present early stage of their development they provided great opportunities for future trade with Great Britain. All of these countries required improved means of transport, communications and, above all, power, but they were very short of engineers. This, said Sir Arthur, was Great Britain's chance to attract young engineering graduates to its own engineering establishments, provide them with practical experience and establish firm and lasting contacts and friendships. In due course these young men might be expected to become very valuable trade ambassadors for Great Britain.

Productivity Report on Plant Maintenance

THE British Productivity Council has now published the report of the specialist team on plant maintenance which visited the United States at the beginning of 1952. In its tour the team visited sixteen plants, which included aircraft, motor-car, brewing, chemical, electronic, oil refining, papermaking, textile and general engineering industries. It also attended the Third Plant Maintenance Show and Conference held at Philadelphia. The report points out that a particular purpose of the visit was to study technical administrative methods rather than actual engineering details of plant maintenance. The report opens with a general critical summary and then goes on to deal with particular aspects of the subject. At the end of a section on the purpose of maintenance and its place in industry, it is recommended that management in this country should review its policy or definition of responsibility and allocation of authority ; that the works engineer should be directly responsible to the chief production executive for the maintenance of production plant ; and that the maintenance of both production plant and general works services should be the sole responsibility of the works engineer. In connection with maintenance planning it is considered that the economics of extending the application of the preventive maintenance approach outlined in the report to industries other than those of the continuously operating kind is worth further investigation. In the general approach to maintenance techniques it appeared to the team that American methods were based to a certain extent upon a freer availability of spare parts and labour-saving equipment. It is recommended that industrial managements and engineering staffs in this country should satisfy themselves that the maximum benefit is being obtained from capital invested in labour-saving tools and equipment and that a greater amount of such equipment should be used.

Aluminium as a Cable Sheathing Material

By D. McALLISTER

No. II—(*Concluded from page* 823, *December* 19*th*)

Now that aluminium sheaths have become firmly established for most types of cable, it is possible to form a balanced picture of their advantages and limitations. For coaxial telecommunications cables, the sheath is an integral part of the cable, but, in the general case, with insulation of paper, rubber, plastics or varnished cambric, aluminium is an alternative to lead and its use does not affect the basic design of the cable. Last week's article gave details of the new techniques which have been developed for sheathing and handling the cables; this article gives an account of the general properties of aluminium sheaths.

The Properties of Aluminium

REPRESENTATIVE values for various characteristics of aluminium and lead are given in Table II. As some of the properties of aluminium are changed by cold work, data are included for extruded tubing and sheaths after dieing down.

Fig. 5 shows the way in which hardness and tensile strength increase with increasing amounts of dieing down. This hardening results in a further increase in stiffness but it is worth noting that the effect is most marked for the smaller amounts of reduction. Although the hardening continues to increase in relation to the reduction in diameter, the rate of increase falls off and even if it were practicable to restrict the sink to small amounts, the advantages gained would not be appreciable.

Fig. 6 shows comparative photographs of cross sections of lead and aluminium sheaths, etched to show the structure and grain sizes. Viewed in this way they are basically similar, aluminium having a grain size rather smaller than pure lead or common lead sheathing alloys. One of the problems in dealing with lead is that the grains can increase in size at quite low temperatures and recrystallisation, i.e. the formation of new crystals and a new structure, can occur at room temperature. Aluminium remains stable at all normal cable operating temperatures.

Another defect of lead not shared by aluminium is in the effect of creep, i.e. the slow but continuous plastic extension occurring under comparatively small loads. In some lead alloys this can result in a brittle fracture with very little extension. Up to the highest cable operating temperatures, and with the 200 lb per square inch internal gas pressure used in impregnated pressure cables, tests have shown that no creep occurs with aluminium.[7] No additional sheath thickness and no sheath reinforcement are necessary for such cables. The internal pressure required to burst aluminium sheaths is of the order of 1000–1500 lb per square inch according to the diameter and amount of reduction in dieing down.

Breakdown by fatigue, i.e. intercrystalline transverse cracking caused by the repeated application of stress, such as occurs due to vibration, has already been mentioned. The high endurance limit for aluminium will be a real advantage as cables can be put almost anywhere without fear of trouble. In this connection, however, some care may be required to avoid the larger but less frequent stresses which can be set up in bends by thermal movements due to heat cycles. Lead-sheathed cables sag between supports and it is generally not too difficult to ensure that changes in length due to heating and cooling are accommodated reasonably uniformly along the length. As aluminium is stiffer, the extension is likely to be transmitted along the cable, and unless prevented by placing cleats at suitable points, the whole extension for a long length of cable might be taken up at one place, e.g. a bend in the route. The movement of cable at this bend could then be quite large and, after a long period of years, fracture by fatigue would be a possibility.

Another big difference between aluminium and lead is in conductivity. Although the higher conductivity of aluminium is not of great importance for power cable sheaths, it is advantageous in high frequency coaxial telecommunications systems as losses are kept to a minimum.

Characteristics of Aluminium-Sheathed Cables

Sheath Thickness.—Standard minimum thicknesses for lead sheaths are given in B.S. 480 and B.S. 7, for cables with paper and rubber insulation, respectively, and consideration is now being given to an extension of these standards or to the preparation of new British Standards to cover aluminium sheathed cables. Meanwhile, British cable makers have agreed on values for present use, the sheath thickness being related to the calculated diameter over the insulation by a suitable formula. There is a minimum thickness of 0·03in, with steps of 0·005in up to 0·05in, and of 0·01in from 0·05in to 0·14in.

The general order of comparison between lead and aluminium sheath thicknesses is indicated in Table III.

For small cables aluminium sheaths of half the thickness of lead are quite satisfactory. Although it is desirable to have the sheath as thin as possible to reduce stiffness, it was not found possible to make a general reduction over the whole range because sheath corrugation occurs on bending if the thickness is reduced too much, and this tendency becomes very much more marked as the diameter increases. Thus, to obtain a satisfactory bending performance, the lead and aluminium thicknesses for cables of about 2in diameter over sheath need to be the same and, for larger cables, aluminium sheaths have to be even slightly thicker than lead sheaths.

Table II.—*Comparative Properties of Aluminium and Lead*

Properties	Aluminium tubing*	Aluminium sheath†	Lead sheath‡
Density at 20 deg. Cent., gm/cc	2·70	2·70	11·37
Weight per cubic foot, lb	169	169	710
Coefficient of thermal expansion (20–100 deg. Cent.) × 10^{-6}	24	24	29
Melting point, deg. Cent.	659	659	327
Thermal conductivity (0–100 deg. Cent.), cals/cm/sec/deg. Cent.	0·54	0·54	0·082
Electrical resistivity at 20 deg. Cent., (ohms-cm) × 10^{-6}	2·8	2·8	20·65
Ultimate tensile stress, tons/sq in	4·5–5·5	5·5–7·5	0·7§
0·1 per cent proof stress, tons/sq in	3·0–4·0	4·5–6·5	—
Elongation per cent on 2in	35–45	7–20	25–35
Young's modulus (lb/sq in) × 10^{-6}	9·9	9·9	—
Hardness, d.p.h.n.	20–25	30–35	4
Fatigue endurance limit,‖ tons/sq in	±2·5 approx.	±2·8 approx.	±0·18

* 99·5 per cent (min.) purity, "as extruded." † 99·5 per cent (min.) purity, after "sinking." ‡ Commercially refined. § Arbitrary value. Varies with rate of application of load. ‖ Stress producing fracture after 10^8 reversals.

Table III.—*Comparative Sheath Thicknesses*

Diameter over insulation, inches	Minimum sheath thickness, inches	
	Aluminium	Lead
0·25	0·03	0·06
0·5	0·04	0·06
1·0	0·06	0·07
1·5	0·09	0·09
2·0	0·11	0·11
2·5	0·14	0·13

Aluminium sheath thicknesses are the same for single and multicore cables, whereas lead sheaths are thicker for single-core cables. The reasons given for this are that single-core cables are often used for terminations and receive more severe handling treatment and that, whilst multicore cables can be armoured to give extra protection and strength, it is unusual to armour single-core cables because of the high electrical losses. Because of the additional strength of aluminium the extra thickness is unnecessary.

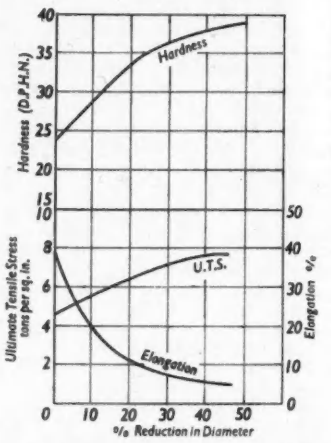

Fig. 5—Effect of Dieing Down on Mechanical Properties of Aluminium Tubing

Effect of Bending.—The standardisation of sheath thickness had, therefore, to be related to what was required in bending performance. Small diameter cables, even with thinner aluminium than lead sheaths, will comply satisfactorily with the test for lead-sheathed cables specified in B.S. 480, i.e. three complete cycles over a hub diameter twelve times the diameter of the cable. With large diameter cables, however, kinking and corrugation of the sheath occur and, although the sheath will not fracture and the effect on the insulation is not likely to be serious, the appearance may be unsightly.

The effect is more pronounced with large cables than with small ones, since the ratio of wall thickness to diameter decreases as the diameter increases. This may mean that plain aluminium sheaths much above 3in diameter are impracticable, because the high wall thickness necessary to obtain satisfactory bending properties would cause the cable to be too stiff to be easily handled.

Because of this corrugation it is recommended that the bending test for aluminium sheathed cables should be two complete cycles at the minimum radius of installation permitted for the type of cable.

Current Ratings.—As aluminium has

greater conductivity than lead, the tendency is for sheath losses to be higher. Although this does not affect multicore cables to any significant extent, the ratings of single-core cables are somewhat reduced, particularly with the usual method of bonding at both ends. For small cables the reduction may not be large, but it increases rapidly with size of cable, and conductor sections above 0·25 square inch are not normally recommended for long route lengths. For short runs the position may be different, however; for example, for three-core cable terminations and for station interconnectors, where single-core cables are frequently used because of the high cost of trifurcating accessories. In these cases an investigation of the economic aspects may show that, because of the lower initial cost of aluminium sheathed cable, the extra sheath losses are tolerable. A study

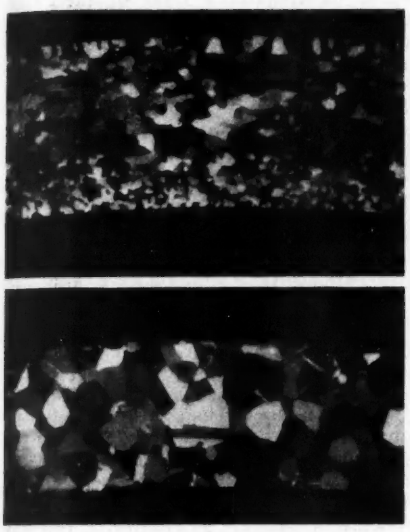

Fig. 6—Etched Transverse Sections of Aluminium (Top) and Lead (Bottom)

is also being made of the possibility of avoiding the losses by suitable insulation of the sheaths.

Where the rating of lead-sheathed cables is governed by a maximum permissible operating temperature without armour, and a higher temperature is allowed for an armoured cable, e.g. power cables, in ducts, it is reasonable, because of the extra strength of aluminium, to permit unarmoured aluminium-sheathed cables to operate at the higher temperature.

Installation

The reaction of engineers installing aluminium-sheathed cables for the first time is invariably one of pleasant surprise that they can be handled so easily. Users have become so accustomed to the incongruous weight of lead sheaths that the somewhat extra stiffness of aluminium is usually offset by the advantages of lightness. Moreover, when laying out cable in many situations the extra stiffness is a help because the cable stays where it is put, so that fewer rollers are needed and it does not sag between supports. The extra force required to bend the cable only becomes really noticeable in forming a small-diameter bend in a short length of cable, e.g. in putting a cable into its final position in buildings. For trench work, or in any position where plenty of space is available, aluminium-sheathed cables are easier to install than lead-sheathed cables. In confined spaces the reverse is true.

To avoid the "waviness," due to the curvature on the drum, which can exist in cable pulled straight off a drum and laid out flat, the use of a ramp with two rollers displaced slightly upwards from the other three (Fig. 7), has proved effective for trench work.

It is also general practice to supply aluminium-sheathed cables on slightly larger drums than are used for corresponding cables with lead sheaths, so as to reduce the tendency to run into any trouble in this respect.

Installation Radii.—The desirability of avoiding excessive bending has already been explained and, for large-diameter cables, it is preferable to use rather larger minimum installation radii. Recommended values and the comparative radii for lead-sheathed cables are shown in Table IV. It is an unfortunate fact that accepted minimum values for such purposes have tended to become working values and, particularly with aluminium, much advantage can be gained by using minimum radii only where absolutely necessary.

TABLE IV.—*Minimum Installation Radii for Solid Type Paper Insulated Cables*

	Aluminium sheathed ($\times D$)*	Lead sheathed ($\times D$)†
Up to and including 11kV :		
Up to and including 1·25in diameter over sheath	12	12
Above 1·25in and up to 2·00in diameter over sheath	15	12
Above 2·00in diameter over sheath	18	12
22kV :		
Up to and including 2·00in diameter over sheath	15	15
Above 2·00in diameter over sheath	18	15
All sizes if drawn into ducts	25	25
33kV solid :		
Single-core cables, laid direct	25	35
Three-core cables, laid direct	25	25
All cables if drawn into ducts	35	35

* D is the diameter over sheath. † D is the overall diameter except for 33kV cables, in which case it is the diameter over sheath.

NOTES

(1) Where the multiplier gives a radius exceeding 6ft a radius of 6ft may be used.
(2) Smaller radii are permitted adjacent to joints and terminals.

The general technique for installations in buildings is to get the cable somewhere near the final position with as little bending as possible, then to work from one end, making each bend and fastening it in position. A convenient drum position for lead may not be the best for aluminium and a rather different outlook is required. If only one bend has to be made and the use of formers or special tools is possible, bends of smaller radii than the above can be made successfully, providing reasonable care is taken to ensure uniformity of bending. If the cable is not well supported a kink may develop at a local section which has bent more than the remainder, and such kinks are difficult to remove. Because of the support given by the tapes, a served cable is easier to handle in this respect than a bare sheath and use had been made of this principle in a successful technique seen by the author recently. A short piece of flexible metallic tubing was slid over the sheath to the position of the bend, tightened up by twisting, and the ends held by taping over: in this way the tubing supported the sheath from the outside during bending.

Supports.—It is not yet possible to specify rigidly the best spacing of supports for all conditions of installation, but half as much again as for lead-sheathed cables may be taken as a general guide. Except on bends, this length may be increased in many cases. It is usual to use open hangers for lead-sheathed cables, but, because of the extra springiness of aluminium, they are quite unsuitable and all-embracing clamps, such as the aluminium alloy claw cleats, are necessary to prevent the cable from lifting out of the support. A convenient cleat which can be fitted quickly is shown in Fig. 8. In the installation of cables above ground in this way special attention should be given to the question of longitudinal extension on load, which was discussed earlier.

Winch Pulling.—The general tendency nowadays is to use winch pulling for power cables laid direct in the ground or in ducts. Over 10 miles of aluminium sheathed, three-core, 33kV impregnated pressure cable, have been laid satisfactorily in this way. A parallel lead-sheathed feeder was installed at the same time and for this method of laying, apart from the lower weight of the aluminium cables, there was practically no difference in the handling of the two cables. An advantage of the aluminium cable was that fewer rollers were needed and the cable was straighter in the trench, so that less work was required in positioning the rollers. In one contract, a stocking grip was used and in another the cables were fitted with pulling eyes. The latter were similar to those used for lead-sheathed cables, the sheath and conductor being plumbed to the pulling eye.

Jointing

In most cases no special accessories are necessary and, with modifications to the method of sealing on to the sheath, the standard designs of joints and terminations

Fig. 7—Special Ramp for Aluminium Sheathed Impregnated Pressure Cable

will probably prove to be quite suitable.

The only basic difference from lead is in the treatment of the sheath in joints having a lead or copper sleeve, alternative methods being the use of a plumb, or of a mechanical union. In the latter case, the end of the sheath is belled out with a special tool and the enlarged portion gripped between a cone and a clamping ring, on which a plumb to the inner sleeve can be made in the usual way.

Lead sheaths are generally plumbed and as this is a particularly versatile method, a suitable technique has been developed for aluminium. Ordinary plumbing methods, even with special solders which will alloy with aluminium, are unsuitable because aluminium is a reactive metal and it is extremely difficult to prepare a clean surface, free from oxide, and maintain it for a long enough time for the solder to form a completely adherent layer.

The following instructions summarise a method which has proved very satisfactory for preparing a "tinned surface" on aluminium :—

(1) Clean the sheath with tricylorethylene.

(2) Remove the oxide film by abrasion with a medium cut file, keeping all the file scratches circumferential.

(3) Heat the sheath with a blow-lamp, until a stick of a special solder will just melt when rubbed on the sheath.

(4) Rub longitudinally with the solder stick until the whole is thoroughly coated with an even film. The rubbing removes the fragile oxide film which forms after filing.

(5) Whilst the tinned layer is still hot, rub circumferentially with a file card. This also removes any oxide formed during the process and helps to obtain a good layer of the solder in intimate contact with the aluminium, by assisting the wetting properties of the solder.

(6) Repeat the application of solder.

(7) Finally complete the wipe with plumbing metal in the usual way, but without the use of tallow. Instead of the Grade "D" metal commonly used on cables, it is preferable to make the final plumb with the antimony-free "J" grade of B.S. 219, or the "H" grade which was in the 1932 issue of that British Standard.

The special solder used for tinning contains zinc or zinc and cadmium. Two compositions which have been found to be satisfactory are 90 per cent tin, 10 per cent zinc and 55 per cent tin, 35 per cent zinc, 10 per cent cadmium. The temperature at which the solder is applied is of the order of 250 deg. Cent., and the cable need not be heated to a much higher temperature than that needed for plumbing a lead sheath.

From the above description, it will be seen that no unduly specialised skill is required for making a wiped joint on aluminium and the technique can be quickly acquired by any experienced plumber. If strict attention is paid to cleanliness and to the specified details, satisfactory results are not difficult to obtain after a little practice.

Corrosion

Intrinsically, aluminium is a chemically reactive metal ; for example, a surface freshly exposed by scraping rapidly combines with oxygen from the atmosphere to form a film, which soon becomes strong and tenacious. Because it is also stable and inert, this oxide exerts a predominant influence on the characteristics of exposed surfaces. Much of the success of aluminium as an engineering material is due to this film, which enables large quantities to be used indoors and often outdoors without any protective treatment such as painting.

A well-known example is the Eros statue in Piccadilly Circus, which has had no protective treatment since casting and is still in perfect condition after nearly sixty years' exposure. Moreover, Eros was made in the early days of the industry when only impure metal was available. It is known that the best corrosion resistance is shown by super-purity metal of 99·99 per cent purity, the grade which is now being used for building purposes such as flashings and weatherings.[8] The slightly less pure grades down to 99·5 per cent minimum purity are not much inferior and the latter is used for cable sheaths, also for "cladding" alloy sheet which otherwise would be more susceptible to attack. Some of the alloys have similar corrosion resistance to the 99·5 per cent grade, and it is only the ones containing copper which are particularly inferior. Another example of satisfactory atmospheric exposure better known to electrical engineers is that aluminium overhead conductors have been used for about 5000 miles of the British grid.

The ability of aluminium to withstand a variety of conditions above ground has been proved by extensive tests. Under some

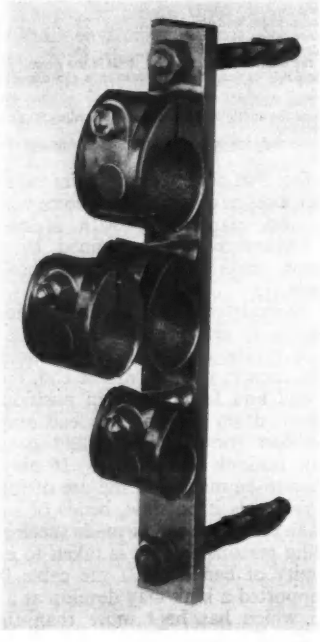

Fig. 8—Aluminium Alloy Claw Cleat for Aluminium Sheathed Cable

circumstances, however, especially underground, the oxide layer may be attacked, for instance, by direct chemical solution in the presence of alkalis or by electro-chemical action. The latter can cause rapid attack if any stray d.c. currents leak to earth from the sheath and a similar kind of attack can occur, even without any stray currents, by the formation of local electro-chemical cells on the sheath in the presence of small quantities of water which can act as an electrolyte. The presence of salts, e.g. chlorides, is particularly detrimental. The whole subject is, however, rather obscure and because the information is limited it is difficult to define the reaction very precisely. For instance, the degree of aeration, i.e. the amount of oxygen present, may play a vital part, and with an inadequately protected sheath differences in the concentration of salts along the route may be important. As a result of local rather than general surface attack, the nature of the corrosion is frequently that of deep local pitting, and although this pitting is particularly marked with aluminium, the characteristics are common to the underground corrosion of most metals. Under very bad conditions a sheath could be completely penetrated by a few tiny holes but almost otherwise unaffected on the surface.

Prior to the introduction of aluminium-sheathed cables, tests on buried aluminium, and the best type of protection to adopt, had not been studied to any great extent. Investigations are now progressing, but until further knowledge is gained it would appear to be essential to use for buried cables a better kind of protection than is used for lead. When laid underground, lead is always served with wrappings of paper and fabric tapes impregnated with bitumen, and although many kinds of soil may be innocuous to aluminium with similar protection, it is desirable to have a serving which will completely exclude moisture, for example, one which incorporates a layer of rubber or thermoplastic material. The reliability of such materials in the protection of steel over lead sheaths has been proved over many years and full reliance may be placed in them for the protection of aluminium.

Above ground, particularly in industrial atmospheres, there is a possibility of corrosion due to the condensation which can result from changes of temperature and humidity, and, as cables are expected to have a long life, it is considered good policy to have some form of protective serving on all cables, except those in dry indoor atmospheres. During installation, bare aluminium should not be placed in contact with fresh cement and plaster ; this point need not be over-emphasised, however, as a coating of bitumen or other suitable paint is adequate to prevent corrosion. Direct contact between bare aluminium and some other metals which are more electro-positive, particularly copper and its alloys, should also be avoided because of the possibility of galvanic corrosion. In the presence of moisture an electrolytic cell can be set up, and as the position of aluminium is towards the negative end of the electro-chemical series, it may be seriously attacked. The situation is not as bad, however, as would appear from the usual list of bare metal potentials because the oxide film again helps by reducing the potential of aluminium.[9] Preventive measures must, however, be adopted and this fact should be considered in fitting accessories. Copper alloys must be cadmium plated or tinned, lead is reasonably safe, but steel or cast iron should be galvanised. If the junction of the two metals can be kept perfectly dry, no corrosion will result, but in cable work it is frequently very difficult to ensure this condition. For the same reason plumbed joints on aluminium sheaths must be well protected either by painting, for relatively dry conditions indoors, or by suitable taping or bitumen sealing for buried accessories.

Bitumen or suitable inhibitor paints containing chromates have proved quite effective for aluminium, but lead base paints should not be used. As previously mentioned, a characteristic of the use of bitumen as a die lubricant is that a good, firmly adherent coating is formed at the die.

Conclusions

The present time can be looked upon as a transition phase. The manufacturing problems, at least for one method of sheathing, have been satisfactorily overcome. Initial field trials revealed the usual teething troubles of new products, but now that aluminium-sheathed cables have been on the market and installed successfully in quite large quantities for a period of four years there is a clear indication that they have come to stay.

The impetus for the original development was the post-war lead shortage. By the time that this had disappeared the claims of aluminium to a place in the cable world had been recognised and its economic advantages proved.

For the future, much depends on the relative prices and availability of aluminium and lead. Though these prices may influence the relative amounts used, it is likely that each will have a particular value for certain types of installation : lead for difficult installation conditions and aluminium where lightness, ease of support or mechanical strength is required. For the big intermediate field, providing a good-quality serving is employed for underground aluminium sheaths, cable engineers can choose either type with confidence.

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Eastham Oil Dock

No. II—(*Concluded from page* 828, *December* 19*th*)

A vast amount of civil engineering work has been carried out since the war as part of the programme of expansion of the oil industry in this country. Apart from the extensive site development works at the various new refineries, it has also been necessary to provide berthing facilities for tankers in a number of cases. The largest project of this kind is probably the oil dock at Eastham, in the Mersey estuary and a short distance from Stanlow refinery, which is described below.

ON reaching a sufficiently advanced stage in the construction of the entrance lock, the first of the caisson gates was floated into position. This operation involved breaching the main cofferdam, after a second cofferdam had been built across the lock below the middle gate recess. This second cofferdam, which is shown in Figs. 12 and 13, is an arched structure, consisting of a skin of Larssen No. 5 section steel sheet piles supported by three concrete arch ribs. The deadweight of the arch ribs across the width of the lock is carried on ex-Army V trestling units adapted for this purpose. The ribs are spaced at 15ft, 26ft and 47ft respectively from the invert, and have cross sections of 10ft by 4ft, 10ft by 3ft and 10ft by 2ft 6in ; the radius of the arch is 82ft 6in. The illustrations give a good idea of the design of this cofferdam.

When the first gate had been floated in, it was again possible to dewater the lock completely, and the cofferdam was subsequently demolished. At this stage it was possible, however, to remove the river cofferdam. The double line of steel sheet piles was extracted and the berm removed in two stages. In the first stage, it was removed down to about the half-tide level, and in the second stage, a Lima 1201 excavator, which had been fitted with a back-acter attachment with a long reach, was employed. The back-acter attachment was designed on the site, to enable the excavator to work to a depth of 35ft below the half-tide level on which it stood, thus digging to the required approach depth of 17ft below L.W.O.S.T. The approach will later be completed by dredging to this depth over a wide area.

The Caisson Gates

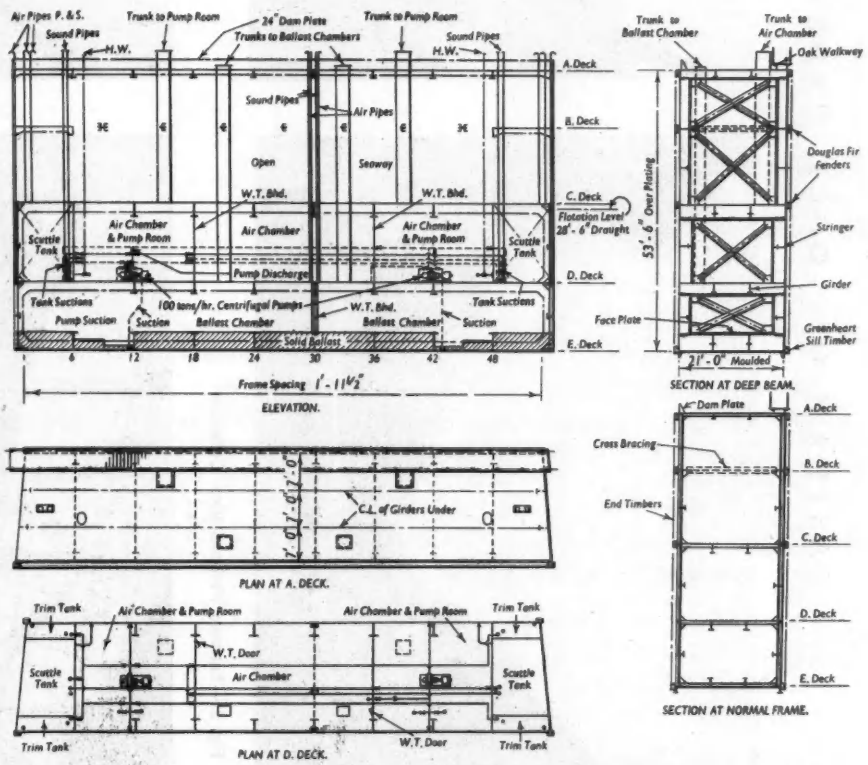
The three sliding caissons of the entrance lock are of all-welded steel construction displacing some 1700 tons, being 106ft long, 23ft wide and 60ft deep. The scantlings of the structure are proportioned to enable the caisson to withstand a load of water up to the top deck on one side, when dry on the other side, this condition giving a total water pressure on the caisson of approximately 5000 tons. The caissons are divided into three compartments by watertight decks (Fig. 10). The upper portion between "A" and "C" decks is a waterway open at the ends. The centre portion between "C" and "D" decks is an air chamber having a scuttle tank and two trim tanks at each end. The lower portion between "D" and "E" decks is a ballast chamber. Solid ballast is arranged on "E" deck and the remainder of this compartment is permanently flooded. Trunks and manholes are arranged for suitable access to the various compartments and tanks. The general arrangement is shown in Fig. 10.

Two electric centrifugal pumps of 100 tons per hour capacity are fitted in the air chamber with the necessary pipes and valves to enable the tanks to be emptied or filled, to pump out the ballast and air chambers and to transfer the trimming water. The amount and position of the ballast is so arranged that the caissons, with the scuttle tanks empty, but with 20 tons of water in the trim tanks, will float at a waterline about 8in below and parallel to "C" deck. The capacity of the scuttle tanks is sufficient to provide a preponderance of about 10 tons when the outside water level is at "A" deck.

The ends of the caissons are slightly tapered in plan, thus facilitating the initial installation and subsequent removal from their normal positions if required. The keels of the caissons are fitted with mild steel sole plates which slide on cast steel ways grouted into the bottom of the grooves throughout the length of the sill and recess.

The watertightness of the dock entrance is maintained by greenheart vertical bearing faces and clapping sills. The caisson grooves in the masonry have been dressed to fine limits and a watertight seal can be made at either side of the caisson as the water pressure dictates. In addition to the three cambers there are also dressed grooves and a sill at each end of the entrance lock, so that caissons may be positioned there to dry out the entire lock for maintenance. The three cambers are each provided with grooves into which a sectional dam can be fitted to seal off any one for dewatering and examination of the caisson. The centre camber has been made somewhat wider than the others to provide room for maintenance or repair work on any of the caissons. Details of the caisson camber, showing the sill and sliding ways, are shown in Fig. 16.

The installation of the first caisson involved breaching the temporary river cofferdam and the caisson was floated through on its side in order to minimise the excavation required. The caisson was towed from Barrow-in-Furness in that attitude and floated over the dam just before high water. It was then moored to the entrance wall, upright (Fig. 12), and later stepped in position across the lock. The method of manœuvring it into position is made clear from the three diagrams of Fig. 15. In the critical



Structural Details

Elevation.—Frame spacing, 1ft 11½in ; frames, 6in by 4in by ⅜in above C deck ; 6in by 6in by ⅜in below ordinary angle toe-welded.
Deep beams as indicated.

Section at Deep Beam

Cross Bracing.—A to D decks, 6in by 4in by ⅜in, OAs backed by 12in by 0·6in plate ; D to E decks, 6in by 6in by ⅜in, OAs backed by 15in by 0·8in plate.
Skin Plate.—A to C decks, 0·6in thick ; C to D decks, 0·7in thick ; D to E decks, 0·8in and 1in thick.
Girders.—A deck web, 12in by 0·4in ; flange, 6in by 0·6in ; trip brackets. C deck web, 20in by 0·6in ; flange, 8in by 1·0in ; T.B. D deck web, 20in by 0·8in ; flange, 10in by 1·0in ; T.B. E deck web, 20in by 1·0in ; flange, 12in by 1·0in ; T.B.
Stringers.—Between B and C decks : web, 18in by 0·6in ; flange, 6in by 1in ; T.B. Between C and D decks : web, 20in by 0·8in ; flange, 10in by 1in ; T.B. Between D and E decks : web, 20in by 0·8in ; flange 10in by 1in ; T.B.
Web Frame.—A to C decks, 23in by 0·6in web ; 12in by 1·0in faceplate. C to D decks : 29in by 0·8in web ; 16in by 1·0in faceplate. D to E decks : 26in by 0·8in web ; 16in by 1·0in faceplate.
Deep Beams.—A deck : 18in by 0·5in ; 12in by 0·7in face plate. C deck : 32in by 0·8in ; 16in by 1·0in faceplate. D deck : 20in by 0·8in ; 16in by 1·0in faceplate. E deck : 41in by 1·0in ; 18in by 1·0in faceplate.

Section at Normal Frame

Beams.—A deck : 4in by 3in by ⅜in, OA stopped 1in short of frames. C deck : 6in by 4in by ⅜in OA. D deck : 6in by 6in by ⅜in OA. E deck (bottom frame) : 8in by 6in by 1in OA.

Fig. 10—Details of Caisson Gate

EASTHAM OIL DOCK UNDER CONSTRUCTION

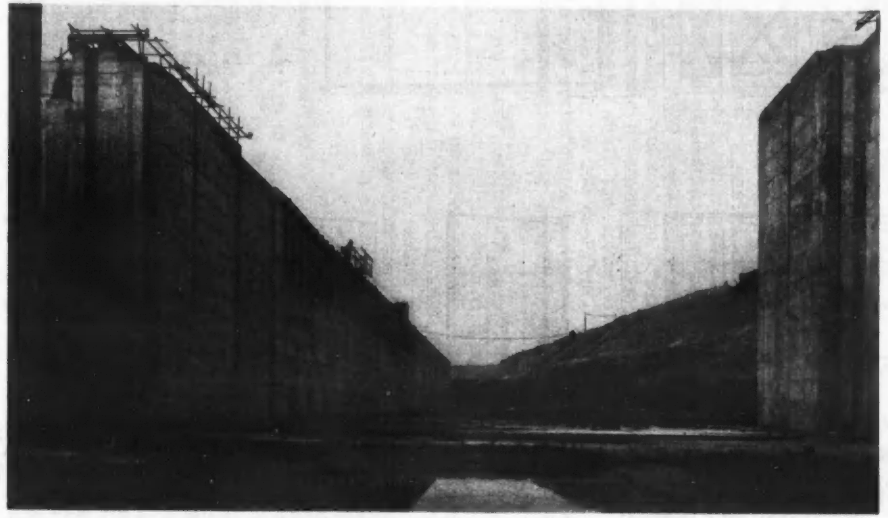


Fig. 11—Entrance Wall and River Cofferdam

Fig. 12—Uprighting Caisson Gate at Entrance Wall

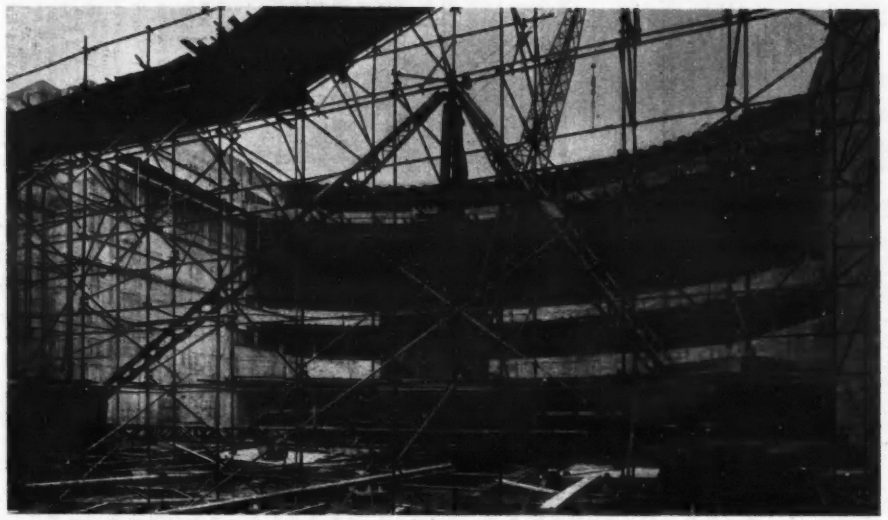


Fig. 13—Arched Cofferdam in Entrance Lock

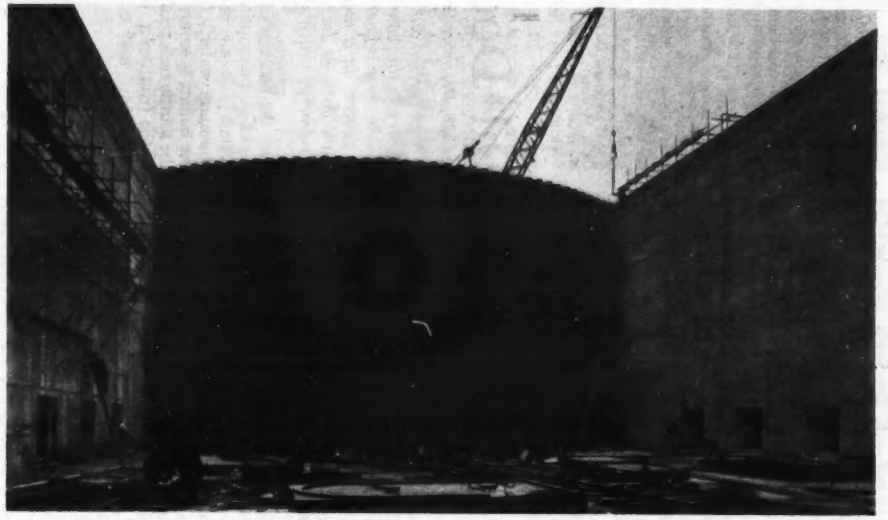


Fig. 14—Arched Cofferdam Showing Concrete Ribs

case of position 4, the clearance was about 2in between the caisson and the lock sides.

The three caissons are operated to open and close the lock by three sets of electro-hydraulic hauling machinery situated in machinery houses in the rear of each camber. One complete set is shown in Fig. 17. Each set of machinery drives two 4ft diameter winch drums which are rove with 6½in circumference steel wire ropes leading round sheaves under the machinery house, which, for the opening motion, are secured direct to the caisson by means of a pivoted yoke crossbar and connecting-rod. The ropes used for the closing motion are led over additional sheaves let into the masonry at the outer end of the camber adjacent to the lock and so back to the caisson yoke.

Basically the operating machinery consists of a 125 h.p. electric motor running at 490 r.p.m. driving a variable delivery pump ("VSG," *A* end) supplying oil under pressure to a rotary hydraulic motor ("VSG," *B* end), which rotates the winch drums through various trains of gearing, the whole drive being duplicated for emergency purposes. In normal operation both drives are used giving a hauling speed of 40ft per minute, but one drive can also be used by utilising a change-speed gearbox to give a hauling speed of 20ft per minute.

The "VSG" hydraulic drive allows smooth infinitely variable speed variation from zero to full speed whilst regulating the speed of haulage automatically to suit the load. It ensures that the designed horsepower is not exceeded, yet the gear is able to exert a high torque and to work over a large torque range. In the event of overload the automatic control gently stalls the machine, maintaining full load torque, without risk of damage or stopping the motor. As the motor has to start against only a very light load it is a simple squirrel-cage machine with a direct-on starter.

To operate the caisson machinery a small controller is provided having a handle in the vertical plane with two neutral positions and three notches on each side of neutral, making a total of eight positions. When the lever is put into the forward neutral position the circuits are selected automatically for closing the caisson. In the rear neutral position it selects the opening circuits, but no movement of the machinery occurs until the lever reaches the third notch, when the caisson will commence to move slowly in the required direction and will accelerate at a controlled rate up to full speed. If the operator should require an intermediate speed he brings the lever into the second or "hold speed" notch, when the caisson will cease to accelerate but will continue to move at the speed which it has by that time attained. Once the caisson is in motion the operator can retard it by moving the lever back to the first notch from neutral. This will cause the caisson to decelerate until either it becomes stationary, or the operator stops deceleration at the desired point by moving the lever to the "hold speed" notch. When the caisson approaches the end of its travel, if the operator has not already reduced its speed, it will be automatically retarded and finally stopped by limit switches.

The delicacy of control described above is achieved by varying the inclination of the tilting box on the "VSG" pumps. This regulates the amount of fluid discharged to the "VSG" hydraulic motors and the direction in which it circulates, thereby controlling the speed and direction of rotation of the hauling machinery. The change of tilt on the pumps is accomplished by a 1 h.p. reversing pilot motor which is geared to both pump tilt levers and is controlled by the operator's hand lever through the medium of a contactor panel. An angular movement of the tilting box in one direction from neutral causes the machinery to haul the caisson open; a movement of the tilt in the opposite direction reverses the gear and thus closes the caisson. The degree of tilt applied to the pumps controls the hauling speed.

As an alternative method of control the caissons can be operated by push button from the lock side by use of change-over switches in the machinery house. It will be readily understood that these caissons have very great inertia and the control of their movements must there-

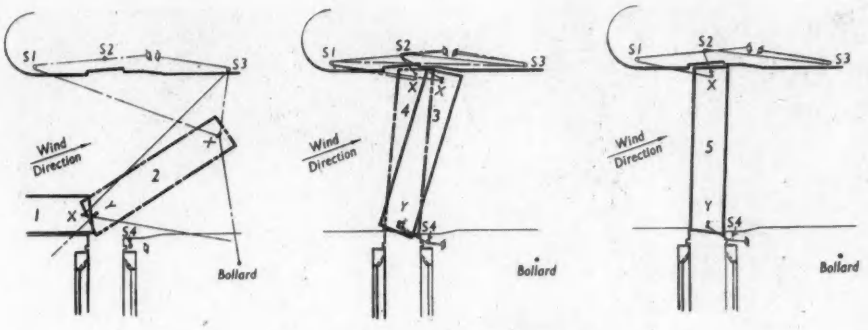


Fig. 15—Method of Installing Caisson

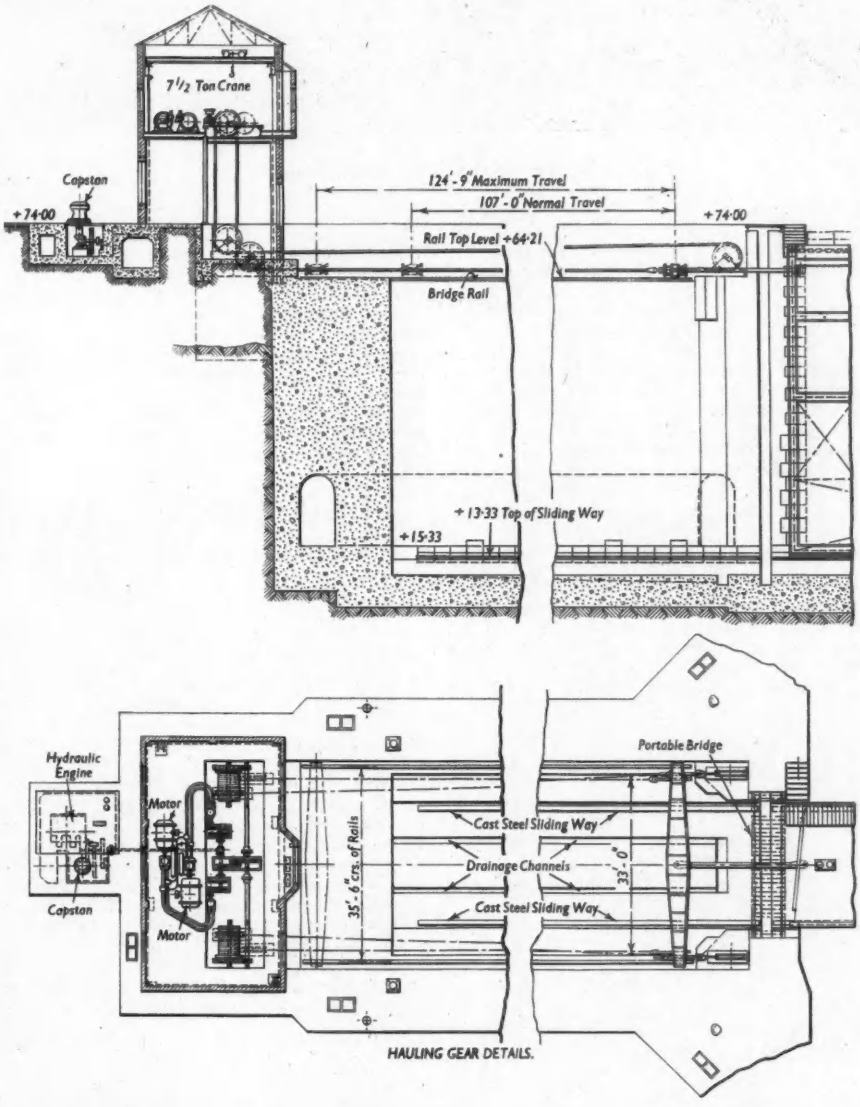


Fig. 16—Layout of Camber and Hauling Gear and Details of Sill Stones

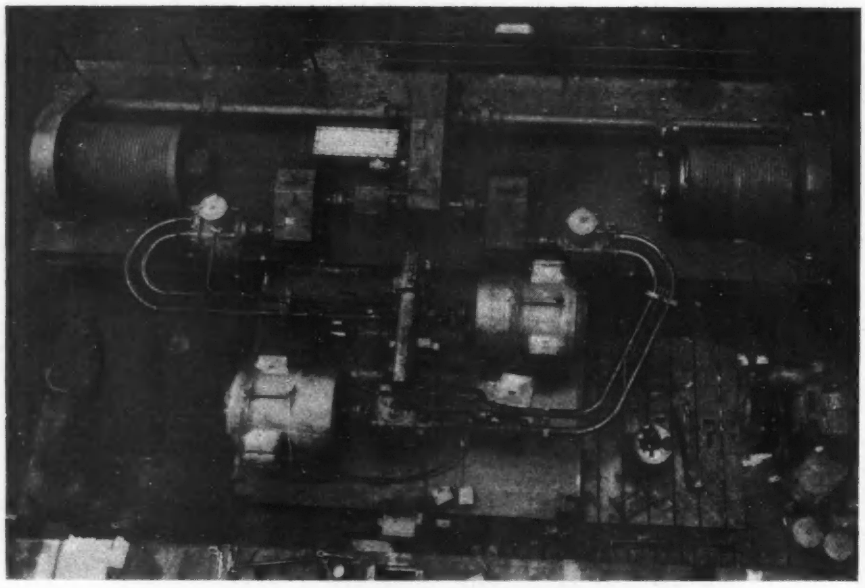


Fig. 17—Set of Caisson Hauling Machinery

fore be precise and sensitive, particularly at the beginning and end of their traverse. The makers state that the use of the "VSG" drive has effectively solved this problem. In the event of complete electric power failure an auxiliary means of opening or closing the lock is provided by a hydraulic engine with three 5in diameter rams and a stroke of 14in, running at 60 r.p.m., taking its water supply from local hydraulic mains which can be connected by clutch to the winch drums. Also connected to this engine is a 10-ton capstan which can be used either for the warping of the caissons about the lock if they are required to be repositioned, or, if necessary, for the passing of ships through the lock.

The Dock

The dock itself is simple in its layout, with mass concrete walls and a sandstone floor, as mentioned earlier, but its position was fixed within fairly close limits by the entrance locks of the Manchester Ship Canal, on the one hand, and the position of the canal crane berth, on the other. The dock will be connected by culverts to the canal and will thus maintain the same water level, which is the high-tide level of the estuary, the canal being replenished at high tides and not by pumping. The dotted lines in Fig. 1 indicate the position of a channel or lock connecting the canal and the dock which may be built in the future if it is required (for instance, should the entrance locks of the canal be reconstructed). There is room at berth No. 2 for a future extension of the dock, should it ever prove to be necessary.

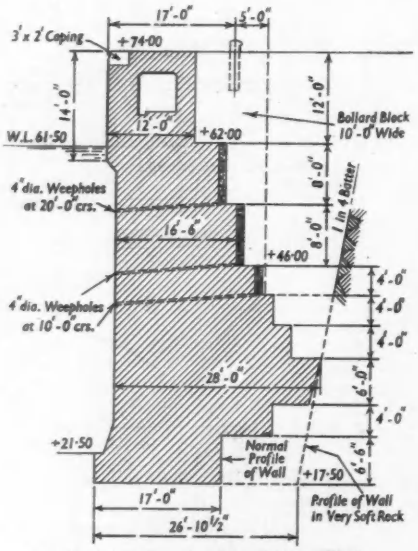


Fig. 18—Cross Section of Dock Wall

A typical cross section of the mass concrete wall of the dock is shown in Fig. 18. This cross section is of the wall at No. 1 berth, but on the other three sides the section is similar, except that there is no culvert for services near the top. The overhang of the wall near the water level should be noted; it is intended to allow for any slight list which might occur in a tanker when it is being unloaded, thus keeping the bilges clear of the wall. An alternative design with an open piled mooring structure round the dock was considered, but would have involved more excavation, amongst other things, and was, therefore, thought to be less economical than the design now being built.

Construction of the dock walls follows generally along the lines employed for the entrance lock, with the same lifts, construction gaps, concrete mixes and shuttering. However, the placing of the concrete again makes use of the conveyor belt system. Conveyors extend from the batching and mixing plant at the entrance lock, round the lock walls to wherever concreting is in progress. These belts are, however, flat and not troughed. They travel at a speed of 280ft per minute, thus allowing concrete to reach the farthest point of the dock, a distance of 1100 yards from the batching plant, in about twelve minutes. The concrete is discharged from the belt into a small hopper, with a vertical pipe leading down to the shuttered area. By this method a rate of concreting of some 2750 cubic yards per week is being maintained. Thus the novel use of belt conveyors has extended to concreting as well as excavation on this site. The method has proved very successful. Up to the present, a volume of 96,000 cubic yards has been poured in the dock walls, and a further 34,000 cubic yards remains to be emplaced.

Eastham oil dock is being constructed to the designs of the chief engineer of the Manchester Ship Canal Company and his staff, and under their supervision. The civil engineering contractors are Sir Alfred McAlpine and Sons, Ltd., and Vickers-Armstrongs, Ltd., is the contractor for the sliding caissons, caisson operating machinery, and the sluice doors; the conveyor plant for handling the excavation was supplied by Richard Sutcliffe, Ltd. It is estimated that the cost of the project will be of the order of £5½ million, and it will probably be completed during the course of next year.

The Euclid Works of the Lincoln Electric Company

(By our American Correspondent)

The new factory of the Lincoln Electric Company at Euclid, a suburb of Cleveland, Ohio, is now in full production. It consists of two main sections: one for the manufacture of welding electrodes and one for the production of arc welding sets. Both the structural engineering principles employed in the design and fabrication of the building frame and the production engineering methods introduced by the company in operating the works are unusual and are described in detail.

THE works of the Lincoln Electric Company at Euclid, Ohio, is designed to eliminate as many as possible of the non-productive labour costs—such as the cost of materials handling within the factory; the cost of setting up production machinery between batches of components (largely due to lack of space for a greater number of machine tools and lack of storage space for a greater number of parts resulting from longer runs) and, finally, the cost of labour and supervision engaged in the keeping of an elaborate system of component inventories.

The factory is illustrated in Fig. 1; it was designed and built by the Austin Company, of Cleveland, Ohio, generally without the services of an independent consultant.

The kind of manufacturing processes carried out by the Lincoln Electric Company did not justify going to the full extent of a "controlled conditions" factory, that is one in which the principal conditions affecting efficient operation, such as light, noise, temperature and humidity, are under full control and independent of natural sources at all times. However, the new building is windowless and has both lighting and ventilation mechanically controlled, and it may be considered representative of the kind of work undertaken by the Austin Company.

Factory Layout

The factory itself is essentially a single-storey structure—1427ft long and 500ft wide—with a service floor centrally situated and 60ft wide, extending the full length of the building, east to west, below ground level (Fig. 2). There is a common entrance for everyone, passing from a simple modern entry building down a double stairway to the service level, where the factory entrance, a two-storey office lobby, a large cafeteria and kitchen, conference and demonstration rooms, and a welding school are accommodated in an area of 120ft by 200ft. All these amenities are situated along a 20ft corridor on the service floor, with locker rooms and sanitary facilities at convenient intervals. Provision has been made for the installation of twenty stairways leading from the corridor to the middle of the production floor at as many different points along its length so that everyone can reach the factory floor within 200ft of his place of work. Building service equipment is contained in areas along the service corridor, facilitating the distribution of power, air, water and other services throughout the factory.

The production of welding generators and other welding equipment is carried on in the west half of the building; the manufacture of electrodes in the east half. Offices are accommodated in a separate two-level "building"—120ft by 360ft—between the two manufacturing departments, surrounded completely by the factory. This arrangement puts production executives immediately alongside the manufacturing areas for which they are responsible, and the despatch department between the pro-

duction offices and the despatch sidings. At the same time, production offices are next to the executive, sales and general offices and the research laboratory of the company. The plant maintenance departments are placed centrally between the two manufacturing units, in an area between the laboratory and a 60ft by 180ft boiler-house, which is adjacent to the factory proper on the north.

Building Structure

The building has a framework of shop- and field-welded structural steel sections and a flat roof. A considerable reduction in the number of columns was made possible by the use of the Austin Company's "H"-section truss, which is described in detail below. In a space 120ft square, for instance, there are only two interior columns. A clearance of 23ft below the trusses has been provided in the production area, permitting materials storage up to a level of 17ft. The clearance is 25ft in the north and south bays, where railway sidings and road transport docks for receiving and despatch are served by suspended overhead transfer cranes.

An unconventional aspect of the building is its insulated curtain wall, which takes the place of some 3,000,000 bricks and occupies an area of 94,000 square feet. A typical wall and roof section is shown in Fig. 3. Aluminium facing sheets, specially rolled to form 3½in deep box sections, 15in wide, are used for the exterior facing. These units extend over a height of 25ft, from the lower 9ft high brick and limestone sill wall to the roof line. The wall is finished off with black aluminium coping. The inner wall consists of 1½in steel panels of comparable height, which have been installed with a 1in "Fibreglass" insulation acting as a vapour seal. The whole of the wall has a thickness of 6½in and weighs 3¾ lb per square foot. It has a heat transfer coefficient of 0·25 B.Th.U., compared with one of 0·50 B.Th.U. for an 8in solid brick wall. The vents formed by the aluminium box sections are open at the top to ensure constant circulation of air and to prevent moisture forming within the wall. The extruded aluminium coping along the edges of the roof prevents water from entering the open vents while permitting air to circulate.

The curtain wall in the course of erection is illustrated in Fig. 4. The 25ft long wall segments are secured to the frame entirely by arc welding and by stud-welded fasteners. In the first instance, ⅜in diameter threaded "Nelson" studs, 3 1/16in long, are installed along girts, which are welded in the frame at three levels; one at the sill line and two above the bottom chord of the trusses. The steel panels, which form the finished interior wall, are punched at three points to fit over these studs and are fastened by arc welding to the girts. An additional girt, which carries a fourth row of studs, is then arc welded to the outside of the steel wall, midway between the sill line and the trusses, to provide an additional means of securing the long aluminium facing panels to the inner wall. Aluminium transition nuts, coated to eliminate the possibility of galvanic action between the steel and aluminium components, are installed next. The "Fibreglass" insulation is then applied and is held in place by 10-gauge headless welding pins, which are stud welded to the steel panels and capped with "Speed-nut" clips.

After the application of the insulation and the vapour seal, the lightweight deep-drawn aluminium panels, which are punched at four points on either side, are placed over the protruding studs, with the transition nuts already in place to ensure proper alignment. Because aluminium and steel have different coefficients of expansion, it was necessary to provide for an extra 1/16in expansion within the 20ft between the main girts. The aluminium panels, therefore, are firmly attached to the steel panels only at the midpoint, and their excess movement is allowed to slide on aluminium shoulders formed on the transition nuts. The assembly of the curtain wall was completed by the installation of the aluminium cap nuts, which screw over the male threads of the transition nuts.

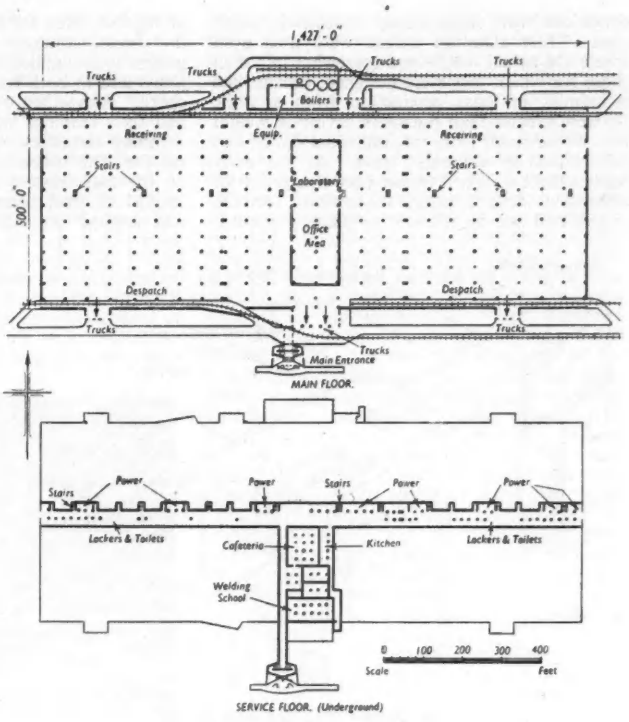


Fig. 2—Floor Plans of Factory

Fig. 1—The Euclid Factory of the Lincoln Electric Company

Ventilation and Lighting

Because of the high clearance under the trusses and the space contained in the trusses themselves, a full air conditioning system on a volumetric basis would have been very costly and would have required an excessive amount of power. It was therefore decided to utilise a localised system of tempered air distribution, which costs less than 30 per cent of a conventional air conditioning installation and uses only one third of its power. This distribution system releases tempered air under pressure only along the assembly lines where most of the men are working. Outside air for the system is drawn in through the roof to a cooling and heating unit in the truss space at the centre of each aisle. Tempered air is distributed from ducts extending down the columns to a point 8ft above the floor. There, outlets direct the air toward the populated areas, and workers benefit as the air sinks to the floor. From there it spreads into the stockpile areas between the assembly lines and is finally drawn out through the roof. Furnace areas in the electrode works are surrounded with metal curtains coming down within 8ft of the floor to trap the heat and the process dust at the source, and exhaust them both before they have an opportunity to spread.

Altogether there are 16,000 linear feet of fluorescent lighting tubes, arranged in two main lighting lines in each aisle, spaced 10ft away from the columns, and with reflectors focused on the assembly lines. Fig. 5 shows the position of a lighting line as well as a row of air outlets in relation to one of the main assembly lines.

The "H"-Section Welded Truss

The Austin Company's "H-Section truss," which is used exclusively in the Lincoln Electric factory structure, is a truss in which all members are of conventional, rolled "H" or "I"-section with the webs of all members lying in the same vertical plane, and with all connections made at abutting surfaces of these "H" and "I"-sections by fillet welds. As long ago as 1913, the company found that there was a real economy in the adoption of "standard trusses": single and double pitch riveted trusses of 50ft, 60ft, 70ft and 80ft spans which were designed and fabricated for a selected live plus dead load, to include the majority of all loading and layout

conditions for single-storey industrial buildings. These standard trusses were used even where the actual loads were somewhat less than those for which they were designed, because the economies in mass production from a stock jig were greater than the small saving in weight that would result from the individual design and fabrication of a special truss. In the early thirties these standard trusses were changed to an all-welded design, using tee-sections for the chords and web members, thus effecting about a

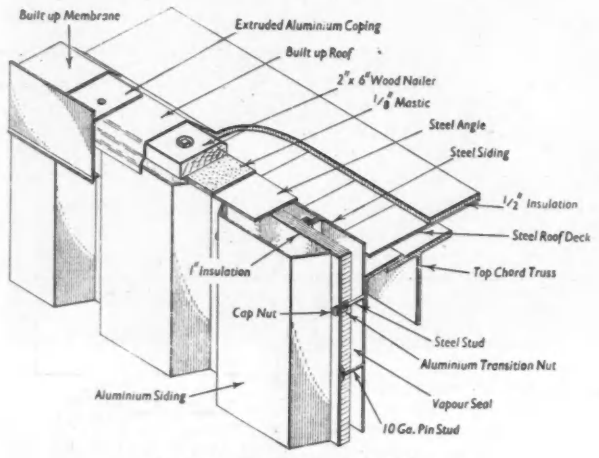


Fig. 3—Factory Wall and Roof Section

20 per cent reduction in weight over the previous riveted trusses. Early in 1944 broad-flange, " H "-sections were first adopted as a basic material for these standard trusses, welded together at the panel points where they intersected (Fig. 6). The " H "-section truss was designed to meet one particular set of conditions as a standard design for the roof trusses of single-storey buildings. It is essentially a single-plane truss and therefore is limited to spans for which single-plane trusses are suitable. However, it is an adaptable truss, since it was found that by simply changing the weights of the truss members (in the U.S.A. a wide range of broad-flange beam weights is available for each given depth of section)—but not their depths—the truss could accommodate increased or unusual loading conditions without changing the jigs which are required for economical fabrication.

After encouraging tests of simple " H "-section joints to check the buckling resistance of webs and flanges, the company decided to proceed with the design and fabrication of two 50ft " H "-section trusses and to test them to failure, the load consisting of 60ft lengths of rolled steel sections, and the increment of load varying from 600 lb to 2275 lb. The two trusses carried a total load of 235,400 lb without apparent distress in any member or joint, but the next increment of 1450 lb caused the failure of the end vertical member of one truss at 253 per cent of the design load. The load was not removed until the next day, and that night further failure occurred at the other end of the same truss. It is interesting to note that despite the considerable impact of the load dropping at failure, the other truss did not fail and after removal of the load was found to have suffered no apparent damage. Throughout the failure all welds held, the collapse having been caused by simple buckling of the end vertical member, which was subjected to more than twice its allowable stress. Based on the observations made at this test, certain minor modifications were made in the design and the " H "-section truss was adopted as the company's standard for roof trusses.

The experience with the " H "-section truss had been so satisfactory that it was felt that some of its principles might be used advantageously in other structural components. Therefore, early in 1946, two series of strain gauge tests were made to obtain information on the stress distribution in the " H "-section type of joint : one with two 80ft standard trusses and another with a special 18ft truss. For the first tests the two standard 80ft trusses were selected at random from the stock on hand and erected on special columns and foundations. Strain gauges were applied principally to the two end joints and to both trusses, in order to provide a check. Altogether, 144 strain gauges were used and their readings were recorded by automatic scanning recorders. Two tests were conducted on the 80ft trusses. As in the previous test on the 50ft trusses, the load consisted of 60ft lengths of steel beams. In the first test load was applied until a total of 174,000 lb was reached. This corresponded to approximately 110 per cent of the design load. Deflection and strain gauge readings were taken at intervals. Then the applied load was entirely removed. In the second test, load was applied to a total of 254,000 lb, which represented the equivalent of dead plus twice the design live load. This load remained on the trusses for about an hour during a thorough inspection of all members and joints. No signs of distortion or excessive strain were observed. The unloading was interrupted by a week-end and a total load of 196,000 lb remained on the truss for more than two days. Then the applied load was finally removed.

Further investigations were conducted on a special 18ft truss under a 6,000,000 lb universal testing machine. This truss was designed for no definite load as the members were selected and disposed to provide certain desired joint configurations. Two of the joints were similar to those on the 80ft trusses and were so made to provide a laboratory check of the field tests. One joint was similar to that in a Warren truss and this joint was so designed that failure would occur there, in order to provide additional data. This truss was subjected to three tests, each to successively higher loads and then back to zero. In the fourth test the load was carried to 175,000 lb, when failure occurred by buckling at the Warren truss joint. Within the limitations of experimental errors these strain gauge tests confirmed that the members of " H "-section trusses may be considered to have a constant cross-section and moment of inertia for their full length between truss joints.

The tests just described may appear elaborate and would normally be expected to be undertaken only in conjunction with such large structures as bridges and arches, not with a simple roof truss. The research programme does, however, become altogether practical and also economical when one considers that owing to the company's policy of standardisation thousands of trusses will be fabricated incorporating any results yielded by this research work.

Summing up, the major advantages claimed for the " H "-section truss are : the full economy of welded design—the entire section of every member is available right up to its end connections ; it is adaptable to a variety of loading patterns. Without changing the panel points, mono-rails and purlins can be placed where desired, since both chords can take bending as well as direct stress : many construction details are simplified. With a beam section as a bottom chord, the top flange provides an ample seat for pipes and ducts and a mono-rail crane may be operated directly on the bottom flange ; since a fillet weld is run completely around all members at their end connections, all cut edges are covered and only the original rolled surfaces are exposed. This increases resistance to corrosion and simplifies painting and maintenance. There is marked economy in fabrication which is extremely important and is evident from the few operations required, namely, cutting the members to length, assembly and welding.

Steelwork Fabrication

As with so many factories it has designed and built for other concerns, the Austin Company has " streamlined " the production layout of its own structural works at Cleveland, where the steelwork for the Lincoln factory was fabricated. There is a straight-line system in which both mechanised and manual materials handling methods are integrated to serve every step of processing from receipt and unloading of raw material to loading of the fabricated product for delivery. Thanks to this basic combination, " H "-section trusses in standard 50ft, 60ft, 70ft and 80ft lengths, together with columns, joists, angles, bracing, girts and eave struts are turned out quickly and economically. Upon receipt by rail at the east end of the shop, steel is unloaded from the wagons by a 65ft span travelling bridge crane equipped with two 10-ton trolleys. It goes either into production immediately or into yard storage to await subsequent processing. On arrival, joists and channels up to 30in size, scheduled for fabrication into beams, columns or truss members, are placed on ball-bearing steel rollers, which are mounted in a rigid frame, anchored in a concrete foundation.

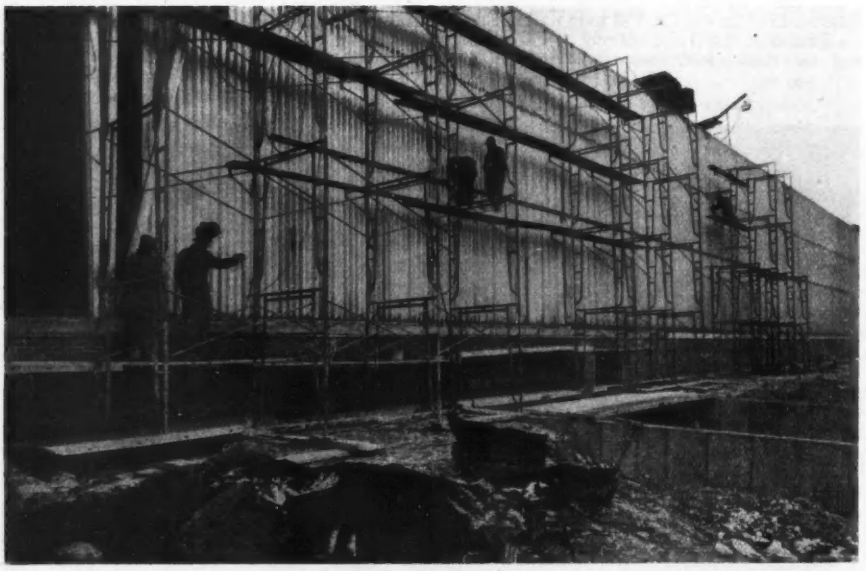


Fig. 4—Erection of Curtain Wall

This installation, covering a distance of 60ft, serves a friction saw, which cuts the steel to desired lengths. Smaller sections for detail beams and channels are placed on another "roller" conveyor unit feeding a second power saw. Material for yard storage is placed on a shop bogie which travels on a standard gauge rail track and is pushed a distance of 60ft to a 660ft mono-rail crane of 4-ton capacity, which carries and stacks the steel in high piles at the selected place in the yard. After friction sawing, the joists move into the shop over another set of steel rollers, and detail beams and channels are transferred to an abrasive saw, which cuts them to exact angles as required of members for "H"-section trusses. The standard gauge rail track, laid flush with the concrete floor slab, runs from the yard through the entire length of the shop to the painting and loading department, directly serving all fabricating areas, which are laid out in a straight line from east to west. After being hoisted to a layout base, the material is marked with templates or by hand for hole punching. Punches of various types and sizes are situated at suitable points in the shop for use in these operations. The second fabricating line starts at the template shop and, like the first line, it is also served by a shop railway track. Both these two lines running through the shops are served at different points by a connecting network of hoists, thus making possible virtually unlimited flexibility in the handling of material through and across the plant during the various stages of fabrication. For assembly, "H"-truss members are simply laid in place in horizontal jigs at the head of each fabricating line. Such jigs not only promote more economical fabrication, but also ensure precise positioning of the webs of all members in the same plane. The initial expense of the jigs is considerable but is justified by the large number of standard trusses they help to fabricate. The chords are placed with the aid of mono-rail hoists; the short members, generally, are so light that two men can place them by hand (Fig. 7). After tack welding, each truss is removed from the jig and stood on the bottom chord, mono-rail hoists holding it at the top. After the bottom chord joints are finish welded, the truss is turned upside down for welding of all top chord joints, facilitating 100 per cent downhand-welding. A.c. welding sets are employed and electrodes correspond to the A.W.S. E6012 classification and, generally, are ⅛in in diameter. As the truss is fabricated completely from rolled steel sections cut to desired lengths, no splitting, blocking, slotting or chipping is required. The fillets, ranging from ⅛in to ¼in, are run completely around the members at their end connections, covering all cut edges and leaving only the original smooth, hard, rolled surface exposed. "H"-section trusses or other structural members, now welded and ready for painting, are carried to the painting and loading department, where they are derusted by wire brushing and descaled by chipping. Following this surface preparation, the work is spray painted with a special chromate yellow prepared to company specifications. In fabricated and finished form, steel is then either loaded directly into wagons on the rail siding adjoining the shop, for delivery to customers, or to the yard where a stock of standard trusses is maintained whenever possible in anticipation of new contracts. Non-standard structural members are fabricated in a special truss shop adjacent to the painting bay. While "H"-section welded trusses in standard lengths comprise the bulk of the output of these fabricating works, flexibility of the shop layout, fabricating sequence and materials handling enable the shops to handle large tonnages of non-standard structural units with the same continuous line production efficiency.

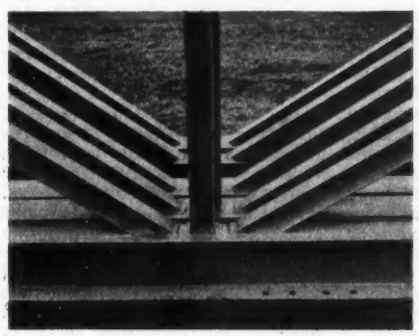


Fig. 6—Panel Point Intersection of H-Section Trusses

Production Flow

All production and assembly operations in the new factory are arranged in lines extending through the building, from north to south, between the enclosed railway siding and receiving dock along the north wall to the despatch aisle at the south wall, where separate rail and road transport facilities serve the two divisions. The factory has been laid out to permit the storage of all material directly at the point of use. In both the fabricating and the assembly areas every item of material is held on the manufacturing floor in a given spot adjoining the equipment on which the next operation will be performed. After processing, component parts move directly to the next operation. There is no intermediate storage or duplicate handling of parts in the works and this simplifies production control and eliminates need for keeping store records. As only one component part or unit can be stored in a given area, the foreman needs only to check the appropriate areas to know exactly how much of any item he has on hand. With the aid of complete advance planning of production, it is possible for the foreman to know what items are required, in what quantities they will be processed, and what operations will be performed. To take full advantage of the possibilities inherent in this layout, the company employs mechanical handling throughout the factory. A transfer bridge crane carries material directly to its first operation position in the appropriate manufacturing bay, and within the bays all major intermediate process handling is done by means of conveyors. Running the full length of each bay, next to the building columns, is a slat conveyor capable of carrying a total weight considerably in excess of 100,000 lb. Welding, machining and assembly stations adjoin the conveyor and work in progress is placed in fixed positions between the machines and the centre aisle.

During processing, material in all bays moves from the receiving toward the despatch aisles, and transfer from the end of one bay to another is made by fork-lift trucks. Overhead cranes in each bay then carry the material to the point of use in this bay. Any movement counter to the flow of work in the bay is made by crane. To facilitate the handling of smaller parts a standard design steel bin was developed by the company. This bin can be lifted by a four-legged grab, or readily moved by fork-lift trucks, and can travel along both the gravity roller conveyors and the main slot conveyors.

In keeping with the incentive system advocated by J. F. Lincoln, the president of the company, many related operations are grouped to form, in effect, small self-contained "factories-within-a-factory" along the production line. Here one man may operate several machines, performing a series of operations, co-ordinating the work within his area with the overall works production needs and, as his own inspector, being responsible for the quality of work produced. The operator may thus consider himself to be a "sub-contractor," who is paid in accordance with the number of acceptable units produced.

Fig. 5—Lighting and Ventilating Units Along a Main Assembly Line

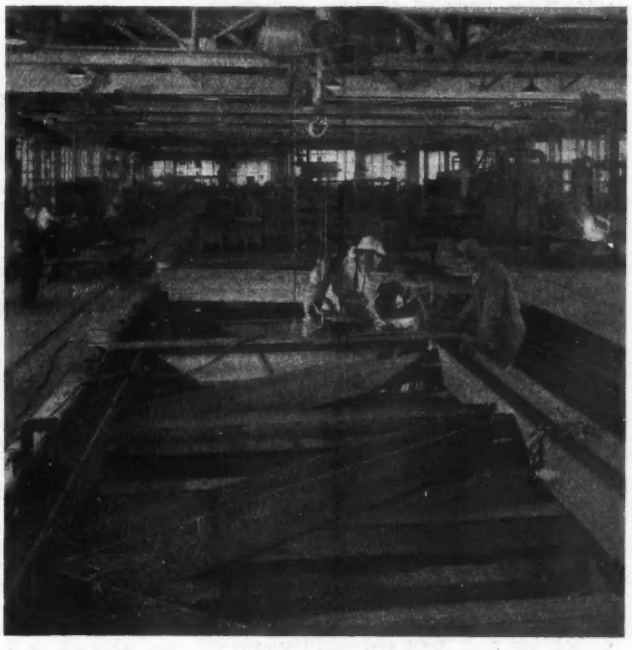


Fig. 7—H-Truss Welding Rig

Metallurgical Topics

Fatigue of Metals

At a meeting of the Society of Engineers, held on December 1st, Mr. B. R. Byrne, of British Railways (Research Department), Ashford, Kent, gave a paper on "The Fatigue of Metals: Facts and Theories Reviewed." In a lucid manner, he gave an account, illustrated by numerous lantern slides, of modern ideas about the mechanism of fatigue of metals leading up to a statistical theory of fatigue failure. Ideally, he said, the endurance limit was the maximum stress (or combination of stresses) at which the component would function indefinitely. Actually, estimates of its value were based on laboratory tests on small specimens carefully prepared from the material it was proposed to use and subjected to 10, or at most 50, million cycles of stress. The value might not apply when the intended service life involved subjection to a much greater number of cycles. The wide and seemingly capricious scatter observed even in carefully planned programmes of endurance testing could be dependent (apart from "assignable causes") on the effects of the orientation, anisotropy and imperfections in the lattice structure of the individual grains. Nevertheless, in many cases the conventional test was the best that could be done; though the "safe" stress range so determined would remain so only so long as the same degree of surface finish was preserved and several other conditions were satisfied.

The *S–N* line, based on points determined in the conventional manner, might be largely fortuitous, depending perhaps on the stage at which it was decided to discontinue sampling the material under test. The line might traverse a range of probabilities embracing extreme values and so might give a most misleading estimate of the limiting safe stress. Many workable designs had doubtless been employed at stress levels above the nominal safe limit. Failures that came under notice from time to time suggested that this not infrequently happened, but expert investigation did not necessarily produce an infallible remedy. It most probably identified the intrusive factor, eliminated it, stimulated more assiduous maintenance, and in so doing brought the ruling value of *S* down nearer to the nominal endurance limit. In other words, it removed the "assignable cause" and returned the system to a condition of "statistical control."

Service Failures

Mr. Byrne instanced threaded connections as representing a class of component more susceptible than any other to failure by fatigue. Fatigue fracture generally occurred near the root of the first or second thread inside the nut. The geometry of the notch was an important factor, and apart from various methods of artificially strengthening the screwed portion, the best threads were those with generous root radii and truncated tips. The best way of improving the endurance of a screwed connection was to form or finish the threads by cold rolling. In heavy components this could not easily be done, but there was no doubt that any ingenuity spent in rolling and burnishing the threads would be well repaid. If heat-treatment was required it should be done before rolling. Alternative methods based on the production of a hard compressed surface layer (e.g. cyanide hardening, carburising or nitriding) involved risk of failure due to grinding cracks and notch sensitivity in the hardened layer. Load concentration could sometimes be reduced by extending the screwed length well beyond that required for engagement with the nut, or by the use of a nut having a lower modulus of elasticity than the bolt. Cast iron, aluminium alloy and magnesium alloy nuts had all been successfully used in this way. In the course of summing up the basic principles of heavy bolt design, Mr. Byrne stated that it was necessary to develop the full elastic strength of the bolt throughout its length, and to see that the bolt was really tight and would remain so. This involved correct design of the members joined, and the avoidance of undue elasticity in washers or other abutments. It was better to preload the bolt to its elastic limit than to risk insufficient tightening. Subject to the need for sufficient plasticity to minimise notch effect (and Mr. Byrne emphasised the importance of this proviso) bolt steels should have a high elastic limit and hardness.

The twenty-second Thomas Lowe Gray Lecture given by Mr. J. Gray to the Institution of Mechanical Engineers in 1950, was referred to as one of the most instructive accounts of a typical fatigue problem published in recent years.

Mr. Byrne's final conclusions were that safe limiting stresses were only approximately predictable, and that a certain proportion of fatigue failures were therefore to be expected, even in the case of a seemingly proven design; that fluctuating stress concentrations, leading to fatigue cracking, flourished in the presence of indifferent workmanship (including design) or neglected maintenance, and that, even when mature consideration had been given to the factors governing the performance of the product, its service life might eventually be determined solely by the exercise of insight and craftsmanship on the part of those who used it.

The paper was followed by a discussion, during which questions were raised about such subjects as endurance limits in corrosion fatigue, effects of understressing, cumulative effects of stress cycles of variable amplitude and frequency, and of periods of rest. Many points raised bore out the statement, made by Mr. Byrne in his opening remarks, that accurate knowledge of certain practical aspects of fatigue was no greater now than it was when he had had occasion to review the subject some twenty years ago.

Residual Stresses in Beams After Bending

For certain engineering applications the elastic limit of constructional members may be increased by overloading them until plastic deformation occurs in regions of peak stresses. Examples are the inelastic bending of beams and the auto-frettage of thick-walled cylinders to increase their elastic limit on reloading. The increase in the elastic limit is due in part to beneficial residual body stresses resulting from the overstrain. The elasticity of overstrained material is impaired —one of the characteristics of the "Bauschinger effect"—and some plastic deformation occurs during unloading. For this reason residual

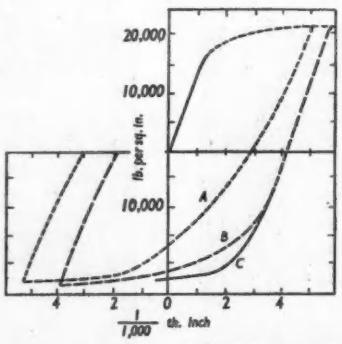


Fig. 1—Tension-Compression Tests on 70 : 30 Brass. Curve A, No Treatment; Curve B, Heated at 300 Deg. Cent. for Forty Hours Under Load; Curve C, No Bauschinger Effect (After Corten and Elsesser[3])

stresses do not reach their maximum possible value. Sidebottom and Chang[1] found that residual stresses in the most strained fibres of inelastically strained beams were reduced 40 per cent or more by this lack of elasticity on unloading.

It has been observed by several investigators that tension and compression specimens behaved elastically on unloading if they were given a low-temperature heat-treatment before the load was taken off, or if they were overstrained at a raised temperature. An investigation was undertaken by T. M. Elsesser, O. M. Sidebottom and H. T. Corten[2] on both axially stressed specimens and on beams, to see whether the full benefit of macroscopical residual stresses could be retained by ageing the member while loaded, and in this way to eliminate the Bauschinger effect before its detrimental effect on residual body stresses could occur. The tension-compression specimens were 3½in long with a ¾in diameter screw thread, 1¾in parallel with diameter ½in and a gauge length of 1in. Beam tests were made on beams of rectangular cross section of annealed mild steel (carbon 0·2 per cent) and rail steel (carbon 0·8 per cent). The mild steel beams were 15in long by 1in wide by 1·5in deep

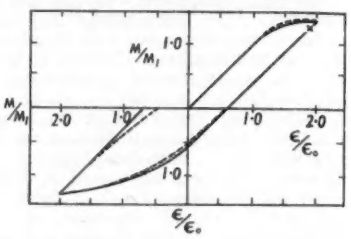


Fig. 2—Cyclic Bending of Beam, 0·2 per Cent Carbon Steel. Dotted Curve, Experimental with Treatment (180 Deg. Fah. for Twenty Hours) Applied at Point X. Full Curve, Theoretical, Taking Account Only of Theoretical Macroscopic Residual Stresses (After Elsesser, Sidebottom and Corten[2])

with two-point loading giving a 5in length of constant moment material. The rail steel beams were 18in long by 1·2in wide by 2·3in deep, loaded at two points 6in apart.

Originally, the elastic limit (σ) of each steel was the same in tension and in compression. In uniaxial tests on mild steel, the Bauschinger effect was said to be nearly eliminated by ageing under load at 180 deg. Fah. for twenty hours (elastic range 1·84σ), and completely eliminated by an ageing treatment of 300 deg. Fah. for twenty hours (elastic range 2·0σ). In rail steel the effect of ageing was far less complete after heating at 450 deg. Fah. for twenty hours (elastic range 1·4σ). In beams the extent of the reduction of the Bauschinger effect was determined by comparing the experimentally found moment-strain data with the theoretical moment-strain curve which was derived on the assumption that there was no Bauschinger effect. In mild steel

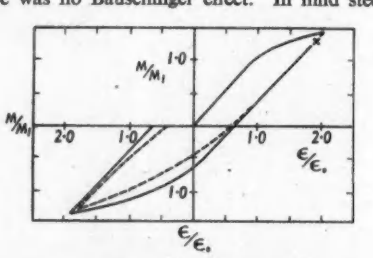


Fig. 3—Cyclic Bending of Beam, 0·8 per Cent. Carbon Steel. Note on Curves as for Fig. 2, but Treatment, 450 Deg. Fah. for Twenty Hours Under Load X.

beams most of the Bauschinger effect was eliminated after twenty hours at 180 deg. Fah. Beams aged under load after overstrain were found to behave elastically during unloading. The good agreement between the theoretical and the experimental curves indicated that the macroscopical residual stresses were preserved, and that the microscopic and sub-microscopic stresses associated with the Bauschinger effect were removed by treatment under load at 180 deg. Fah. Although a similar treatment diminished the Bauschinger effect in rail steel, the beam still exhibited considerable inelasticity when subjected to reversed loading.

It was concluded that if a beam was subjected

to overstrain, which, in the absence of Bauschinger effect, should give 30 per cent increase in elastic strength if reloaded in the same direction, the actual increase (without ageing under load) would be about 15 per cent. By ageing under load the full 30 per cent increase would be obtained.

In another paper, H. T. Corten and T. M. Elsesser[3] examine the effect of moderate heating on the microscopic and sub-microscopic stresses induced by inelastic strain in metals. The work was carried out on mild steel and on 70 : 30 brass. Fig. 1 represents the behaviour of 70 : 30 brass tested axially, without treatment and also aged at 300 deg. Fah. for forty hours under tensile loading. In producing Figs. 2 and 3, representing the behaviour of beams of 0·2 and 0·8 per cent carbon steels, the moment M was computed for each reading and divided by the maximum elastic moment M_1; the strain of the most stressed fibre (ϵ) was divided by the yield strain (ϵ_o). The diagrams show ϵ/ϵ_o plotted against M/M_1. Figs. 1–3 are simplified reproductions of the more detailed diagrams given in the papers.

It is to be noted that improved strength is shown only on reloading in the same sense. Although the total elastic range is restored by overstrain and the suggested ageing treatment, the elastic limit in compression is lower than its original value, and the beam or specimen is only able to resist a lower load in the opposite sense to that applied in overstraining. After overstrain in tension, the elastic limit in compression is not restored until a treatment at about 850 deg. Fah., which reduces residual stress to a low value, is employed.

The advantage of overstraining at a raised temperature was pointed out about forty years ago by Professor John Perry, and has long been recognised in theory. The process has been utilised to some extent in the "setting" of springs, but there are often serious practical difficulties in carrying it out on a large scale.

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[1] First U.S. National Congress of Applied Mechanics, June, 1951.

[2] "The Influence of Ageing on the Bauschinger Effect in Inelastically Strained Beams," *Trans. Amer. Soc. Mech. Engs.*, November, 1952, page 1291.

[3] "The Effect of Slightly Elevated Temperature Treatment on the Microscopic and Sub-Microscopic Residual Stresses Induced by Small Inelastic Strains in Metals," *Trans. Amer. Soc. Mech. Engs.*, November, 1952, page 1297.

Temper Brittleness

AT the thirty-fourth annual Convention of the American Society for Metals, held in October last, three papers were presented on various aspects of temper brittleness. Dr. L. D. Jaffe and his associates, continuing their series of papers on the subject, reported on the "Effect of Various Heat-Treating Cycles Upon Temper Brittleness" (Preprint No. 25). The work was carried out on quenched and tempered nickel-chromium steel containing carbon 0·39, manganese 0·79, nickel 1·26 and chromium 0·77 per cent. Portions of the material were subjected to twenty different temper embrittlement cycles involving slow and rapid heating and cooling, with and without isothermal holding at one temperature. The temperature of transition from tough to brittle fracture was determined after each treatment. The increase in transition temperature produced by a treatment was considered a measure of the degree of embrittlement caused by the treatment. Quenching to room temperature between tempering and isothermal temper embrittlement had no significant effect on the resulting embrittlement. Most of the embrittlement produced by slow cooling from the tempering temperature of 675 deg. Cent. developed above 500 deg. Cent. For the heat investigated, embrittlement developed more rapidly in treatments involving continuous cooling than during isothermal heating at any temperature. When several embrittlement treatments were applied successively to the same specimens, each contributed to the embrittlement, but the combined effect was often less than the sum of the effects of the individual treatments applied separately.

A second paper by the same authors (Preprint No. 26) dealt with the "Effect of Hardness on the Level of the Impact Energy Curve for Temper Brittle and Unembrittled Steels." The work was carried out on the same nickel-chromium steel, and the principal conclusion was that "for steels of the same hardness the impact energy level is higher for the unembrittled than for the temper embrittled material." The impact energy level in this connection, means the constant value of impact energy stated to be reached at some testing temperature well above the transition temperature. Fig. 1 shows the difference in impact values (Charpy V-notch) reached by the tough and embrittled nickel-chromium steel at 200 deg. Cent. above the respective transition temperatures. Embrittlement was carried out by a treatment for forty-eight hours at 500 deg. Cent. on specimens tempered at different temperatures to produce different degrees of hardness. The figure also shows a linear relationship between impact energy and Rockwell hardness numbers between C–27 and C–38. The values plotted were derived from smoothed curves, and individual results do not appear to show so regular a difference. It may be doubted whether the wide generalisation contained in the main conclusion is always justified. With some steels there seems to be evidence that the impact values do not remain constant over a long range of temperature, but that the impact energy/temperature curves of the two states gradually merge into one another and follow the same course as the testing temperature is raised.

THE ENDURANCE LIMIT OF TEMPER-BRITTLE STEEL

A paper with the above title, by R. D. Chapman and W. E. Jominy (Preprint No. 23), gives an account of an investigation of the effect of temper brittleness of a chromium steel, containing carbon 0·37, manganese 0·75, and chromium 0·98 per cent, on the endurance limit at both room temperature and at −37 deg. Cent. Three different heat-treatments were applied to give material of the same hardness, but with different impact values and transition temperatures. Both polished and notched specimens were tested in fatigue in a Moore rotating beam machine running at about 8000 r.p.m., or 3000 r.p.m. at the sub-zero temperature. Results are shown in Table I. In addition, smooth and notched tensile, and standard V-notch Charpy impact specimens were tested at the same temperatures, with the results shown in Table II. In spite of the considerable difference in Charpy impact values, no substantial change in endurance limit was found between the embrittled and non-embrittled material at the two temperatures studied. The results also indicated no change in the notch sensitivity factor of endurance specimens between the embrittled and non-embrittled steel. The authors conclude that temper brittleness has no effect on the endurance limit of the steel tested, and that in engineering applications, where a temper-embrittled steel was used, the endurance limit of the part would be unaffected, even at temperatures below the transition temperature.

These results are further confirmation of the widely accepted view that the single-blow, notched-bar impact value of a steel has no influence on its fatigue limit.

TABLE II—*Tensile Properties of Polished and Notched* Specimens of Embrittled and Non-Embrittled 1 per cent Chromium Steel*

Treatment	Temperature of test, deg. Cent.	Impact value, ft-lb	Type of specimen	Yield strength, tons/sq in	Tensile strength tons/sq in	Elongation, per cent	Reduction of area per cent	Hardness, Rockwell C
1	24	93	Smooth	52·4	60·1	31	64	28
3	24	42	Smooth	54·0	60·6	29	58	28·5
1	24	93	Notched	82·7	90·9	4	35	28
3	24	42	Notched	86·0	93·2	3	26	28·8
1	−37	78	Smooth	56·8	63·8	29	62	28·5
2	−37	23	Smooth	58·4	64·6	31	61	29·5
1	−37	78	Notched	—	96·1	3	32	27·5
2	−37	23	Notched	—	98·4	3	29	29·5

* Radius 0·059in, depth 0·09in, diameter below notch 0·300in.

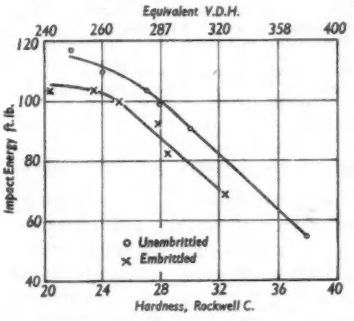

Fig. 1—Relation Between Impact Energy and Hardness of Tempered Martensitic Nickel-Chromium Steel at 200 deg. Cent. above the Transition Temperatures (Carr, Goldman, Jaffe and Buffum)

Copper-Nickel Alloys

THE *Nickel Bulletin* for October, 1952, contains a useful summary of the properties of copper-nickel alloys containing less than 50 per cent of nickel. These alloys, varying in tensile strength with increasing nickel content from 20 to 32 tons per square inch in the annealed condition, have excellent low-temperature properties, while some compositions modified by the addition of iron and manganese (e.g. I.C.I. "Kunifer 30") have a notable resistance to creep. The principal applications of the commercial alloys are: 95 : 5 modified by additions of iron up to 1·5 per cent and some manganese, a copper-smithing alloy for construction of sea-water pipelines where impingement attack is encountered; 90 : 10 modified by additions of iron and manganese of about 2 per cent, steam condenser tubing, feed heaters and other heat exchangers; 80 : 20, suitable for severe cold working, bullet envelopes; 75 : 25, coinage; 70 : 30, modified by additions of iron and manganese up to 2 per cent each, condenser tubes and other heat exchangers, and 55 : 45, with almost the lowest thermal and electrical conductivity of the copper-nickel series, electrical resistance material on account of its negligible temperature coefficient of electrical resistance.

TABLE I—*Endurance Limits for Embrittled and Non-Embrittled 1 per Cent Chromium Steel*

Treatment	Temperature of test, deg. Cent.	Charpy V-notch impact value, ft-lb	Endurance limit, tons per sq in		Hardness, Rockwell C
			Smooth bar	Notched bar*	
1	24	93	34·4	19·6	28
3	24	42	33·5	19·2	29 and 28
1	−37	78	36·2	19·6	27 and 29
2	−37	23	37·0	21·9	29

* 60 deg. V-notch, root radius 0·035in, depth 0·09in, diameter below notch 0·300in.

ROLLS-ROYCE "AVON" PRODUCTION.—It is announced that negotiations for the manufacture of the Rolls-Royce "Avon" gas turbine aero-engine in Sweden have been completed. To meet initial requirements some complete engines will be exported from Great Britain and pending establishment of Swedish manufacturing facilities, engine parts and components will also be supplied. Production of the "Avon" engine in Sweden will be undertaken by Svenska Flygmotor A.B. Sweden's latest jet fighter, the J-32 "Lansen," at present undergoing flight trials, is powered by a Rolls-Royce "Avon" engine.

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TRIALS OF STANDARD LOCOMOTIVES

The fourth *Bulletin* appertaining to steam locomotive performance and efficiency tests to be issued by the Railway Executive is of particular interest as being the first to deal with one of the new British standard types, the class "4" mixed traffic 4–6–0. This engine has a high nominal tractive effort of 25,515 lb, practically equal to that of the well-known Stanier class "5" 4–6–0 of the former L.M.S.R., but with no axle-load greater than 17¼ tons the new class "4" has a considerably higher route availability. It can therefore be expected that much of the work allocated to these new 4–6–0s will be of a light or secondary nature, including freight trains. The *Bulletin* sets out, in the usual lucid manner, the results of full thermodynamic trials carried out on the stationary testing plant at Swindon and supplemented by controlled road tests made on the Western Region main line between Wantage Road and Filton. Two separate sets of trials were run, with Blidworth and Bedwas coals, respectively, and in each case the trial procedure was the same as that described in THE ENGINEER for June 13th and 20th and July 4th and 11th, in connection with earlier trial results published by The Railway Executive. This latest *Bulletin* will be studied all the more carefully in that a new standard engine is concerned, though the possibilities of comparison with earlier engines of this same power class are practically non-existent. Among engines of the 4–6–0 wheel arrangement there have, in the past, been Bowen-Cooke's "Prince of Wales" class on the former London and North Western —all now scrapped; and Holden's "1500" class Great Eastern 4–6–0. Only the Great Western "Manors" are truly comparable and no test results have yet been published from these. There are also Maunsell's three-cylinder 4–4–0 "Schools" class on the Southern and, of course, the Midland compounds.

So far as "all-out" haulage ability is concerned the "Schools" must come very close to the new 4–6–0. A careful analysis of a number of pre-war runs between Waterloo and Southampton shows the "Schools" developing outputs of 950 to 1050 drawbar horsepower for 45 minutes on end, at average speeds of 55 to 60 m.p.h., while the new class "4" tested at Swindon gave much the same, while working in 30 to 35 per cent cut-off. But no full-dress trials were carried out with the "Schools" and in any case comparison cannot be extended further, since Maunsell's engines were designed purely for express passenger work. The cylinder performance of the new standard engines is excellent and with a steam rate of 19,600 lb per hour the indicated horsepower is 1410, sustained from 60 m.p.h. up to 75 m.p.h. Naturally, interest tends to be directed towards the details of maximum achievement, though the occasions when a class "4" 4–6–0 will be required to sustain such an output as 1410 i.h.p. for any appreciable time are likely to be few. Nevertheless, the following details taken from the *Bulletin* will be of interest. With the sustained steam rate of 19,600 lb at 65 m.p.h. the cut-off was 30 per cent and the coal rate 2835 lb per hour, or 43·5 lb per train-mile. The drawbar horsepower was 930 and the coal consumption per drawbar horsepower hour the commendable figure of 3·1 lb. The actual figures quoted are those obtained with Bedwas coal. The engine steamed equally well when fired with Blidworth coal, though the consumption of this latter, which has a lower calorific value, was consistently higher: at the same speed and output 50 lb per train-mile, and 3·5 lb per drawbar horsepower hour. If, however, the actual consumptions are related to the price of the coals as delivered on the tender at Swindon Motive Power Depot, the disparity is cancelled out, since the price of Blidworth, at the time of the tests, was 57s. 9d. per ton, against 67s. 1d.

In view of the probable activities of these new engines the characteristic curves for coal consumption per ton-mile and per drawbar horsepower hour over the whole speed and load range are of particular interest. In freight service the engine shows a very economical performance when working at slow speed with heavy trains. At 15 m.p.h. on a rising gradient of 1 in 200, with a load of 800 tons, the coal per drawbar horsepower hour is 2·5 lb. In lighter loading conditions, however, say, running a 200-ton passenger train at 60 m.p.h. on the level, the corresponding coal rate is 4·5 lb per drawbar horsepower hour. In this latter case the actual consumption would be no more than 25 lb per train-mile, but all the same, heavy in relation to the work done. The general tendency of these curves is to fall as the load rises. In passenger service on level road the most economical load at 70 m.p.h. is 320 tons, while at 60 m.p.h. it is 500. But both these points occur as the maximum steaming capacity of the boiler is approached and are thus hardly practicable for inclusion in day-to-day timings on the road. The tendency of the curves being what they are, there might well be some inclination, in working out revised train timings, to favour heavy loadings and lower speeds. This, of course, would be in direct opposition to public demand both in passenger and freight service, and the fact, revealed by these tests, that to run a 250-ton train at 70 m.p.h. on the level takes 31·3 lb of coal per train-mile against 28 lb to run a 400-ton train at 55 m.p.h. must be faced. Class by class the performance characteristics of our modern locomotives are being set forth in these admirable *Bulletins*. A further step would seem to be the adjustment of design details for each class to give the most efficient working in the range of power output wherein the highest proportion of the road service is done.

ROAD TRANSPORT AND ROAD RESEARCH

There is a story in Aesop's fables about two cats who found a piece of cheese. They were unable to agree about sharing it, and a monkey volunteered to do so for them. He divided the cheese unequally, however, and had to take a bite from the larger piece, which, of course, then became the smaller one. By adroit repetition of this stratagem, he ate all the cheese, and the cats had none at all. Road transport users and operators watching the politicians' bites at nationalisation and denationalisation while their real need is for improved roads to suit improved vehicles, no doubt, have feelings as frustrated as the appetites of the two cats. For it is not the political organisation of an industry—or a nation—which, primarily, makes it prosperous. It is the technical skill exercised in that industry and the value of the goods or service which it provides that is the more important factor. Improvement in the efficiency or productivity of an industry may far outweigh the disputed advantage to be gained from a change of ownership or administration. A perusal of the recently published report "Road Research, 1951," is a forceful reminder of the possibilities inherent in such improvement, as they might be applied to road transport.

About 10 per cent of the community's expenditure on goods and services of all kinds was spent, directly or indirectly, on road transport during the years 1949 and 1950; about £1060 million was spent on road transport and travel in 1949 and about £1220 million in 1950—that is about three-quarters of the total expenditure in all forms of internal transport and travel. These

figures are derived from a detailed study of expenditure during these two years which has been made at the Road Research Laboratory, and which is given in some detail in the report. The significance of this knowledge and the use to which the Laboratory will apply it, may best be indicated by quoting from the Road Research Board's report : " We have kept constantly in mind the function of the road as a channel for trade and for the flow of community life. The particular need, at the present time, is to make the road system play its full part in assisting the nation's drive for increased productivity. Any serious attempt to relate expenditure on roads to the economic return from the road system requires knowledge : knowledge of how roads are used and what the nation spends in using them ; knowledge of how to construct, maintain and improve them at the least cost, and knowledge of accidents, how to reduce their numbers and what it costs to do so. The aim of road research is to provide this knowledge so that the effect of measures to increase efficiency can be properly judged." In the body of the Director's report are to be found matters—too numerous to give in detail here—relating to analyses of vehicle and street lighting, braking, skidding, accidents, motor cycle accidents, traffic statistics, and so on. To give one example, one survey indicated that the proportion of vehicles having a rear light whose intensity was really adequate under the worst conditions was one in four for private cars, motor cycles or public service vehicles ; one in five for commercial vehicles, and one in fifty for cycles. Analysis of the accident statistics suggested that the absence of the rear lights or their inadequacy was responsible for about 3400 night accidents each year, which involved people being injured. This was 9 per cent of all night-time accidents and represented a probable financial loss to the nation of some £2,000,000. That part of the Road Research Laboratory's work covering materials and methods of construction is not neglected in the report. The subjects in this section are grouped under the headings of " Economy in Road Construction : Pavement Design," " Soils and Aggregates," " Concrete," " Bituminous Materials," and " Other Investigations," which in this case concern road surface characteristics and snow fences. Much valuable work, of the high standard which is now normally expected from the Road Research Laboratory as well as from other of the D.S.I.R.'s laboratories, is embodied in this section.

It is no reflection on the value of the primarily technical matters comprising the second group of subjects, that those wider aspects under the headings of " traffic," " safety " and " economics," should receive more attention, for they concern, in one degree or another, all road users—that is, the whole community. We have commented in these columns on many occasions—and there are frequent examples of highway engineers and other authorities expressing similar viewpoints—about the inadequacy of the present road system in this country. Virtually nothing at all is being spent on road improvement and even maintenance is severely limited. The road research report covers a wider range than this, however, but in doing so adds force to the arguments for better roads, and for more economical and, most important of all, for safer, road travel. The report should be read widely—by motorists and pedestrians as well as by engineers. Above all, it should be read by those, of one political view or another, who concern themselves more with the road transport industry's ownership than its efficiency and its safety. The knowledge which the Road Research Board has set out to acquire will, doubtless, be of great value in the future. Perhaps its greatest value will be in adding to the arguments, already overwhelmingly convincing in our view, for taking drastic action to modernise the road system, so that there can be no doubt in any mind of their validity.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

LOCOMOTIVE EXPERIENCES

SIR,—A correspondent has asserted that locomotive cut-off indicators " in general are quite unreliable . . . in estimating cut-off " and that " most enginemen are aware that the cut-off indicator reading does not mean much." It is even inferred that an engineman only knows that the cut-off control is not in backward gear because his engine is running forward (*vide* the issue of October 24th). No explanation is offered to prove the existence of such alleged defects in reversing gears, or why they are tolerated if they exist. No remedial measures are suggested for combating such an unsatisfactory state of affairs. Are locomotive designers such nitwits that they continue to fit mechanisms which are worse than useless and, therefore, a waste of money ? The old G.E. Railway fitted an air-operated reversing gear incorporating an elaborate and costly controlling, " follow up " and indicating unit installed in the cab. Presumably the money sunk in these reversing gears was a sheer loss from the viewpoint of assisting drivers to control the engines ?

Why are cut-off indicators " in general " so unreliable ?—if, in fact, they are. Working models of valve gears, devised to allow valve events to be studied, respond properly to the reversing gear and the cut-off positions are indicated accurately. Is it possible that locomotive builders are unable to construct valve gears and reversing mechanisms which will have the accuracy of the models ? Possibly those engines which should be running backwards according to the cut-off indication are badly in need of " shopping " and have suffered such wear that the valve gear is somewhat akin to a collection of old iron. But if this is the explanation of unreliable indications why condemn all indicators by stating that in general they are quite unreliable? Some constructive suggestions for the cause and cure of the alleged unreliability would be interesting and helpful.

Turning to the description of the new Garratt locomotives from New South Wales (THE ENGINEER, October 31st) is there any record of the performance of the automatic water release valves located on the sides of tanks and connected to the cylinders by comparatively long pipes ? Presumably, the engines have normal cylinder cocks in addition and, furthermore, that these cocks are used regularly by the drivers. It is difficult to believe that the automatic valves would be effective in view of the lengths of piping involved—possibly that is the explanation of the railway company's standard practice of providing breaking grooves in the cylinder covers ? What would happen to the " motion " if a rear (or end) cover failed ?

The writer has been acquainted with vertical stationary engines which were wrecked because automatic relief valves—actually on the cylinder covers—were unable to release water rapidly enough on starting. What, then, of the remote relief valves on these Garratt engines ? Why are they placed in the remote position shown ? The connecting pipes increase the clearance volume, and heat loss, and it is difficult to see what advantages are derived from the layout.

It would be interesting to learn why the engine units of a Garratt locomotive are not reversed, or turned end to end, in order to reduce the length of the steam and exhaust pipes. In the case of the New South Wales locomotive there would be a reduction of approximately 25ft in the length of steam pipes, &c., for each engine unit. Obviously clearances between the cylinders and the girder frame carrying the boiler unit would necessitate careful attention in the design stage, but the problem would not be any more difficult than that which was solved by the designers of the mallet locomotive.

Reference to the Mallet design prompts one to ask why the Garratt locomotive has never been adopted in Canada and the U.S.A.

E. B. PARKER

Wirral, Cheshire,
December 12th.

SIMPLICITY IN GEARS

SIR,—Professor Tuplin, in his letter in your issue of December 12th, disclaims any proposal for identity between worm threads and screw threads. What he actually said was " A helical gear is nothing more than a screw and on the face of it you would expect to be able to cut a helical gear on the same simple basis as you do a screw—and, in fact, you can." My point is that " the same simple basis " is only true for threads straight-sided on the axial section ; since we agree that this shape should not be employed and that the involute helicoid should be, we have lost some of the sameness and simplicity and it is a matter of opinion how far the analogy between worms (or helical gears) and screws can usefully be pursued owing to their different final uses.

I agree that interchangeable gears from various manufacturers *should* be made from prints off the same drawing : I was speaking from bitter experience of what in fact did happen. A number of gear pairs was ordered from each of several manufacturers, who redrew the drawings to suit their own shop and in doing so altered " unessential " dimensions to suit their equipment.

EWEN M'EWEN
Reader in Applied Mechanics.

University of Durham,
Newcastle upon Tyne, December 15th.

THE ENGINEERS' GUILD

SIR,—I agree that there is much truth as well as common-sense in the comments made by Mr. England in his letter of December 5th. However, in order that an engineer, or for that matter, a member of any other learned profession, may attain a status in keeping with his calling, it is essential that he shall obtain qualifications of the highest standard. Nothing less will suffice.

Corporate membership of one or more of the three " senior " Institutions covers this requirement. These bodies cater for the three main branches of engineering. At its inception the Guild was wise to restrict its membership to those possessing these qualifications.

Many of the highly specialised but much smaller Institutions and Societies are doing first-class work and most of them require qualification by examination as well as evidence of practical training before admitting candidates to corporate membership. But a point I would emphasise is that corporate members of the Institutions of Civil, Mechanical and Electrical Engineers are very often members of one or more of the small, specialised bodies and play an active part in their affairs. These men,

however, are primarily Chartered Civil, Mechanical or Electrical Engineers, as the case may be.

It might be difficult to widen the basis of the Guild, though I concede that there is an argument for doing so. Comparisons are invidious but surely such organisations as the Royal Aeronautical Society and the Institute of Marine Engineers, to mention but two, have their own important fields to themselves. Their requirements for membership qualification are exacting.

JOHN FOX

Hove, December 17th.

A GAS TURBINE LOCOMOTIVE EXPERIENCE

SIR,—Mr. Livesay's letter on this subject reaffirms his belief that locomotive running is often recorded in far finer detail than seems useful. This is specially true when the performance is mediocre, as it usually is in Britain to-day, but Mr. Livesay is perhaps equally open to criticism in filling so many column-inches in reaching the same conclusion as an opinion, where a few lines of figures would demonstrate it as a fact.

Locomotive footplate riding is no doubt desperately dull and Mr. Livesay seeks frequent refuge in the train, where many of his observations might have been made. One result is that some of his recent articles have contained only a very small amount of the type of information that warrants publication in a technical journal.

G. KITCHING

Boston Spa, Yorks, December 15th.

Aircraft Production Conference

THE conference held last Friday and Saturday by the Institution of Production Engineers to review the subject: "Problems of Aircraft Production," produced many forthright discussions, following the presentation of the papers in each session. The conference was held in the University of Southampton and the proceedings began with an address by the Parliamentary Secretary to the Ministry of Supply, Mr. A. R. W. Low, following the opening luncheon. At the afternoon session Mr. Walker, chief designer of the Gloster Aircraft Company, Ltd., and Dr. Russell, chief designer of the Bristol Aeroplane Company, Ltd., each presented a paper on the theme "Designing for Production," and at the evening session there were two papers on a theme, "Prototype to Production," by Mr. C. E. Fielding and Mr. H. Povey, works directors of A. V. Roe, Ltd., and de Havilland Aircraft Company, Ltd., respectively. Many aspects of civil and military design and production problems were mentioned in these papers and most spiritedly debated in the ensuing discussion periods, but at this stage we can only briefly refer to one major problem which emerged.

The first speakers had begun by suggesting there would be no problems if all production engineers were good ones and if there were no bad designers. Several members thought that in view of the present aircraft requirements there was certainly a shortage of good designers and production engineers and there was growing evidence of a rift between them. Methods of improving the co-ordination between these two departments were discussed at great length. It was suggested that as the result of a present tendency the best apprentices went into the design office and the worst into production planning. Several other speakers suggested the real need for a production research engineer to help bridge this gap and there seemed a measure of agreement that both could profit from a greater appreciation of the other's problems if higher productivity was to be attained.

The Saturday morning discussion followed a paper on "The Impact of Modifications on Production," by Mr. H. S. Howat, assistant director, Aircraft Production, Ministry of Supply.

Literature

Thermal Properties of Buildings. By N. S. BILLINGTON. London: Cleaver-Hume Press, Ltd., 42*a*, South Audley Street, W.1. Price 25s.

IN recent years rapidly increasing attention has been given to problems on heat transfer in buildings, and numerous papers dealing with particular topics of this important branch of applied science have been published by workers in many countries, particularly on the continent of Europe and in America. The need has long been felt for a collected work, drawing together in a single volume the results of research from this wide assortment of scattered papers, and written in a style at once appropriate to the theoretical and practical interests of those concerned with the subject. The author has attempted to satisfy that need and can justly claim to have succeeded so far as the collection and presentation of results is concerned and the account of the work that produced them. The numerous tables, together with the list of 130 references will make this a valuable reference book. The author very rightly draws repeated attention to the importance of thermal capacity not only as an obvious element in the design of buildings for hot climates, but also as a frequent causal factor of condensation. From a concise, though somewhat technical account of the physical principles which govern the non-steady heating characteristics of buildings, the answers to many practical problems which beset the designer who has to deal with this very complex subject, are derived. However, little purpose is served by devoting ten pages to an abstruse appendix on the elaborate mathematical solution of particular examples of non-steady heat flow. This highly-specialised treatment is allotted no less space than the whole chapter on comfort and warmth, a very important subject which might well have been dealt with more comprehensively, especially in such a book as this, of which the majority of readers will be architects and heating engineers. The chapter on condensation is particularly good; here, many readers will become acquainted, perhaps for the first time, with a quantitative study of the subject and will welcome especially the conclusions derived from the analysis to form a basis, supported by experiment, on which to formulate methods of remedial treatment.

The concept of equivalent outdoor temperature could usefully have been included in the account of the causes of condensation, instead of being introduced later in the book, and there expressed in a form which does not account for certain phenomena observed in condensation.

Scientifically, the book is generally sound, though there are a number of points on which the specialist in heat transfer is likely to disagree with the author. These, differences, however, are academic and do not detract from the general usefulness of the book.

X-Ray Crystallographic Technology. By A. GUINIER. English translation, edited by K. Lonsdale. Hilger and Watts, Ltd., 98, St. Pancras Way, Camden Road, N.W.1. Price £2 16s.

THIS translation of Guinier's "Radiocristallographie" (published by Dunod, Paris, 1945), is a welcome addition to our technical literature on X-ray methods, for it presents a description of the theory and practice not only of the principal methods which are already well established in this country but also of those techniques and refinements of technique developed by the French School and by Guinier in particular, which merit more general application by workers in this country.

Some modifications of the original text have been made but they have not included any detailed consideration of technical developments since 1945.

The book is intended to be a manual of experimental methods and related theory for the technical expert in applied X-ray research rather than for the crystallographer. Some single crystal techniques of general importance are included but the theory and experimental methods concerned with structure determination are omitted.

Parts I and II cover the general theory of the generation of X-rays, their interaction with matter and the elements of crystallography. Part III deals with the relevant experimental methods for single crystal and polycrystalline specimens. In this section the chapter on monochromators and techniques involving strictly monochromatic radiation will be welcomed by many workers.

Part IV describes the general kinds of application of X-ray methods. The author's intention has been to assemble the facts, both theoretical and experimental, which will enable the X-ray worker to select and apply the most appropriate technique and to interpret the observations. He has intentionally limited himself to a discussion of experimental methods and does not discuss the results which have been obtained by these methods. This procedure will be welcomed by the expert working in this field, for it simplifies the plan of the book and reference to specific techniques and diffraction effects, though it will inevitably reduce the appeal of the book for experts in other related fields who may be more concerned with the correlation and significance of the results obtained by X-ray methods.

The general applications discussed are crystal texture (size, shape and orientation of crystals, single and in aggregate), crystal lattice characteristics and variations (chemical identification and analysis, precision lattice measurements, lattice stress-strain and order-disorder changes), crystal imperfections (line broadening effects, thermal agitation, cold work), diffraction by amorphous substances and, finally, the application of low-angle scattering methods to the determination of particle size. Minor points of criticism are the occasional lapses in the form of too literal a translation and the inadequate emphasis in the appendices on the fact that all wavelengths and parameters are given in true Angstrom units. During the transition from kX to Angstrom units all tables should be preceded by a clear indication of which unit is in use.

Development of the Guided Missile. By KENNETH W. GATLAND. London: Iliffe and Sons, Ltd., Dorset House, Stamford Street, S.E.1. Price 10s. 6d.

ALTHOUGH much of the matter presented in this book has previously appeared in papers by the author, the collation of the material forms a useful guide to the unrestricted information on the subject. He paints a rather depressing picture of the state of British rocket and guided missile development and it would appear that he is justified in doing so. The unnecessary secrecy surrounding British work in this field is largely responsible for the present lack of workers. Indeed, we recall the time when, although full details of German rocket missiles had been published in the United States, similar data on propulsive systems could not be released for publication in this country. The usual professional answer that the information is available for those working on the problem is not a sensible

one. It is the new research worker outside the field who needs to be attracted to it. Gatland agrees that security is essential but stresses that the awakening of interest in Britain's young technicians and university graduates is equally important. If this country is to feel safe from aggression in the coming years a great deal of technological effort must be devoted to the development of guided missiles.

In an extensive introduction the author lays stress on the vulnerability of the British Isles to attacks from the European mainland. He points out that all our expensive defence programme may be useless if the attack comes from supersonic missiles instead of conventional jet bombers. Moreover, he informs us that Russian scientists are developing winged missiles from the German A-9, which can have a range of 370 miles. On the construction of long-range rockets some interesting figures are quoted. The Germans reached a peak production of thirty rockets per day for an expenditure of some 3000 to 7000 man-hours per rocket. The important point appears to be that this was the result of semi-skilled slave labour, the class of labour which Soviet Russia should have in abundance.

But the whole of the book is not so depressing. After explaining the many forms of guided missiles, their development, their uses and the function of the light engineering industry in their manufacture, the author indicates some future peaceful uses for these machines. He describes the sounding of the earth's atmosphere by high-altitude rockets such as the Viking and the Aerobee. He specifies the requirements for instrumented, minimum weight, artificial satellites; orbital missiles which can circle the earth indefinitely at the limits of the atmosphere. Finally, he discusses the ultimate possibilities of interplanetary flight introducing the reader to missiles which can bring man a wealth of important physical information instead of a welter of destruction.

Much useful information is presented in the Appendix, in which all known guided missiles which have been declassified in any way are listed, together with important data, such as weights, dimensions, propulsive systems and notes concerning their uses and development. The book is well illustrated, is quite suited to the general reader who has not previously approached this subject, and forms a most useful introduction to this new and rapidly growing industry of the guided missile.

Frame for Testing Structures

By B. H. FALCONER, B.E., Ph.D., and S. R. SPARKES, M.Sc., Ph.D., A.M.I.C.E.

A frame for testing structures in use at the Imperial College of Science and Technology is described. The frame is capable of applying four tensile loads of 25 tons each anywhere within a space of about 22ft by 9ft by 9ft, a single load of 50 tons, two loads of 50 tons acting at right angles to each other, or two tensile loads of 50 tons each, to produce a couple.

THE design of machines for testing structures has not received the same attention as that for testing materials because structures cannot usually be made to a suitably small scale, and also the loading required is not always planar. The testing of civil engineering structures has been limited to the testing of specimens of the materials of construction, of fabricated structural components, and in some cases to the testing on site of the completed structure.

In the aircraft industry the need for testing completed structures of similar form has led to the design of very large structural test frames like the "Cathedral" at the Royal Aircraft Establishment, Farnborough, and the frame used by the Bristol Aeroplane Company at Filton. These test frames are, in effect, through bridges with structural members joining the top chords. At the Royal Aircraft Establishment the longitudinal members of the frame are braced girders, and transverse loading beams span between the upper and lower chords. Vertical loads

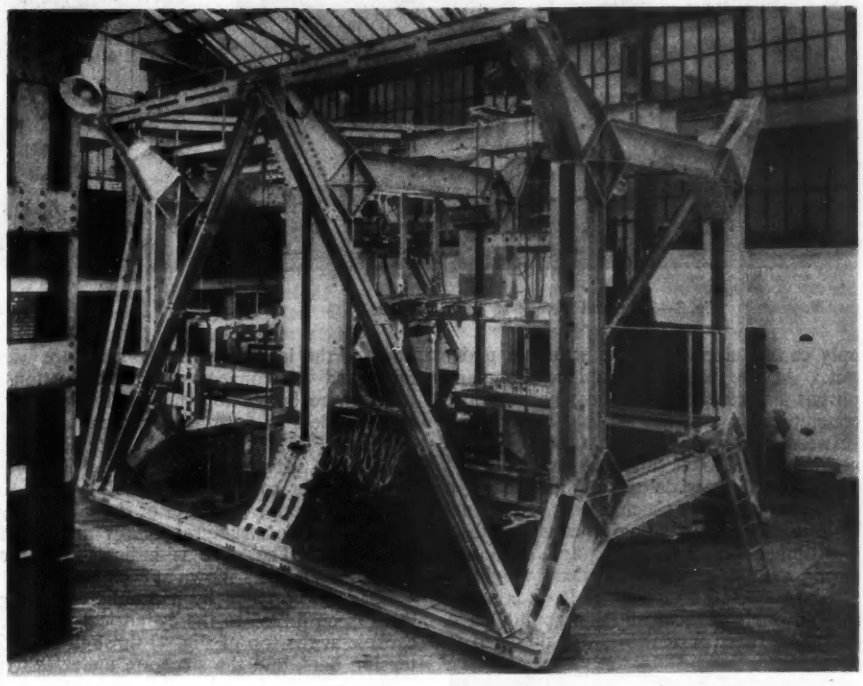


Fig. 1—General View of Frame

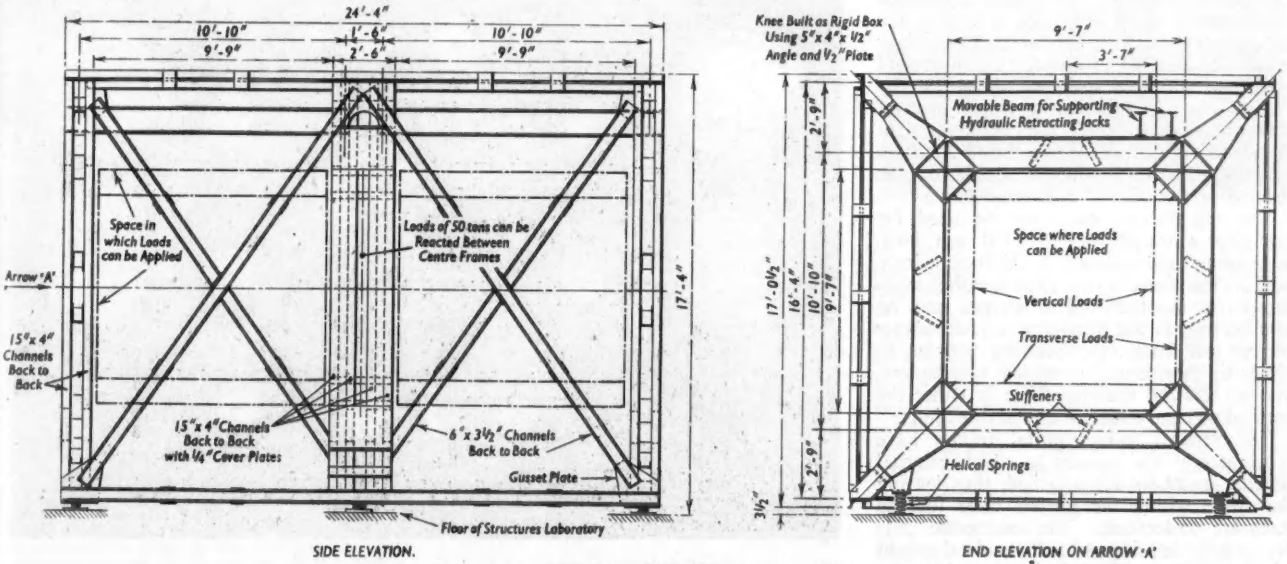


Fig. 2—Space Frame for Application of Test Loadings

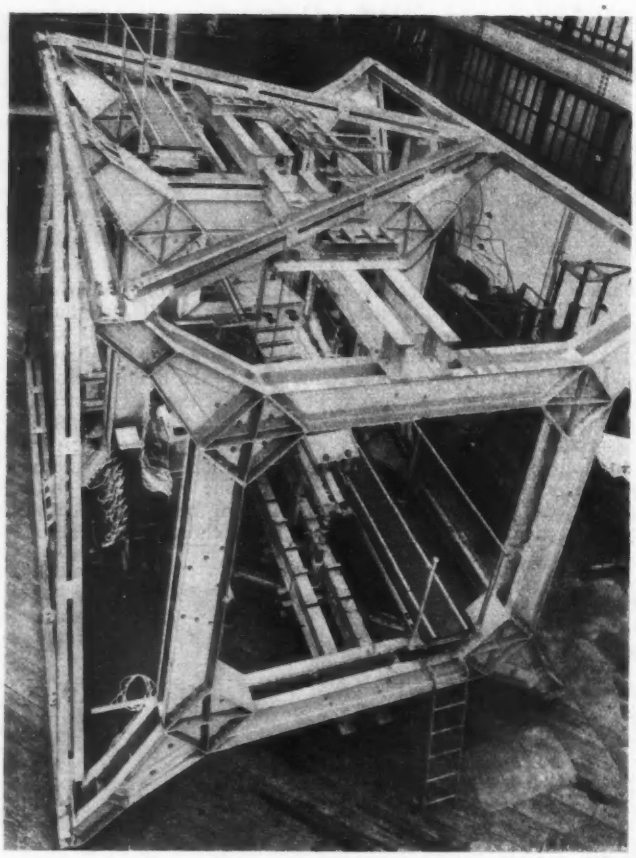


Fig. 3—Structural Details of Top of Frame

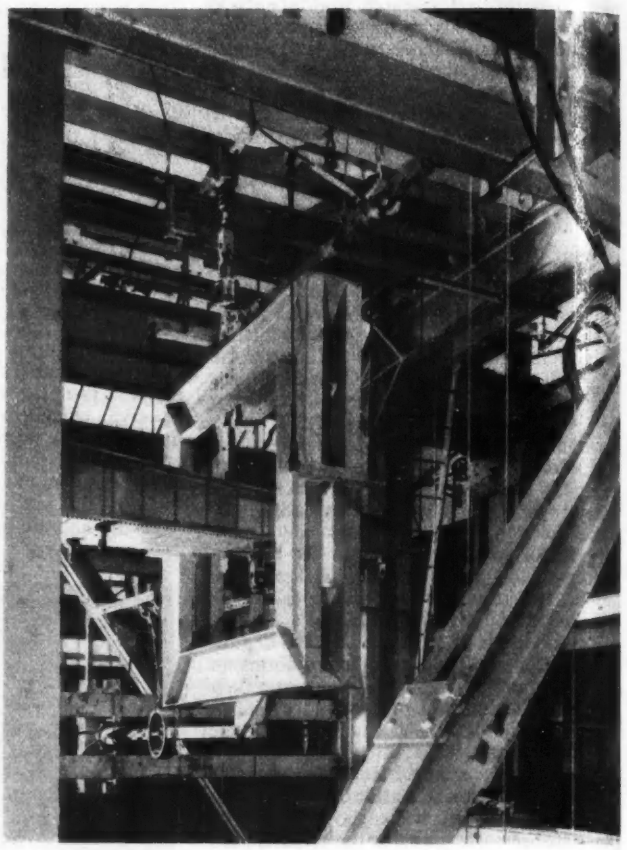


Fig. 4—Applying Shear and Torsional Stress

only can be applied to the structure under test. At the Bristol Aeroplane Company portals are fixed to a stiff, heavily reinforced concrete base and the loading beams span between the portals so that both vertical and horizontal loads can be applied.

Neither of these designs is suitable for a structures laboratory such as that at Imperial College, where the floor is constructed of 3in timber on steel joists, and was only strong enough to carry the dead weight of a test frame and structure. Also it is necessary to apply vertical and horizontal loads, and so a space framework was designed in which loads applied to the structure under test were equilibrated within the framework.

The frame shown in Fig. 2 is, of course, very small compared with those mentioned above but it is as large and strong as can be accommodated in the laboratory. Four tensile loads of 25 tons each can be applied anywhere within a space of about 22ft by 9ft by 9ft. In addition a single load of 50 tons, two loads of 50 tons acting at right angles to each other, or two tensile loads of 50 tons each, to produce a couple, can be reacted in the central transverse frame.

The test frame may thus be used for applying a torque up to 2100 ton inch, a bending moment up to 3100 ton inch, and a shear force up to 25 tons either separately or together. The torque can be applied only in the transverse vertical planes of the test frame, the bending moment in either the horizontal or vertical longitudinal planes, and the shearing force in either the vertical or transverse horizontal directions.

The vertical square portal frames have outriggers at the corners to which external bracing members are attached, thus leaving the space within the portals clear for the structure under test. The test frame rests on six helical springs so that the dead weight of about 20 tons is well distributed to the floor of the laboratory. The structure was fabricated in conveniently sized sections, which were bolted together on the site and then welded to form the complete portal frames. Fig. 1 shows, from ground level, the frame with a tapered box 16ft long under test in torsion and bending. Fig. 3 was taken from eaves level of the laboratory and shows the structural details on top of the frame. The scale is indicated by the steel access ladders shown at each end.

Loads are applied by hydraulic retracting jacks (seen linked to the cylindrical pressure capsule at the top of Fig. 4) through pinned tension bars, and the structure under test is appropriately supported by tie bars pinned to bearers on the central portal frames. The jacks can be bolted to any point on the beams spanning between the outer and inner frames (Fig. 3) and the beams can be moved around the perimeter of the portal frames so that horizontal and vertical loads can be applied anywhere within the test space. Loads are measured by pressure capsules and calibrated rings. Levers with ratios of two, three and four to one can be incorporated in the loading linkage as shown in Fig. 1 so that loads between 2½ tons and 25 tons can be applied with at least half-scale deflection of the load measur-

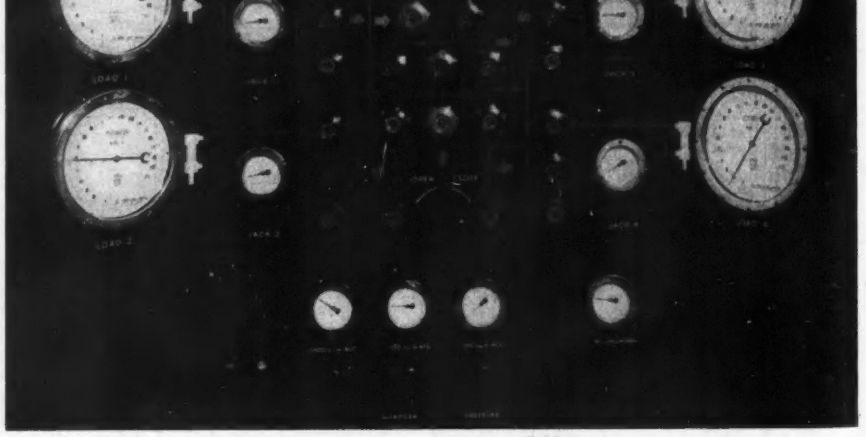


Fig. 5—Control Panel

ing instruments. The jacks have an 8in travel and were adapted from commercial jacks by fitting longer barrels and piston rods and low-friction oil seals. The loading linkage is counterbalanced by weights hung from pulleys as seen on the left-hand side of Fig. 1, so that its dead weight is not applied to the structure under test.

Fig. 4 shows a device for applying a range of shear and torsional components of load, in such a manner that the magnitudes of the individual components can be measured directly with the same relative accuracy. The shear component was applied directly by the single vertical acting jack. As the two horizontal jacks acted in opposite directions, and the test girder was unrestrained laterally, the two applied forces were necessarily equal. Consequently the square frame was subjected to a twisting couple, which it transferred to the box girder through the vertical connecting links shown in the photograph.

The frame has been designed so that point loads can be applied within a large area and since, in any but the simplest cases, the application of load at any point affects all other loads, it is essential that instantaneous values shall be measurable. Remote reading pressure capsules have been found to be convenient for this purpose since the diaphragm movements are extremely small and readings are not affected by friction like those of pressure gauges connected to hydraulically operated rams. The pressure capsule gauges and load control valves are mounted on a control panel (Fig. 5), from which loads can be applied through the jacks individually or collectively. A diagram of the hydraulic circuit is painted on the control panel, together with operation instructions. A pressure up to 2000 lb per square inch is obtained from a hydraulic accumulator fed by a motor-driven pump.

The tension bars in the 10-ton loading linkages were made from 2¼in by 1¼in mild steel bar, the corresponding fork ends and universal links were cut from 2¼in mild steel square bar, and the pins were of 1in diameter DTD 331 high tensile steel. Linkages to carry the full load of 25 tons are made of DTD 331 high tensile steel.

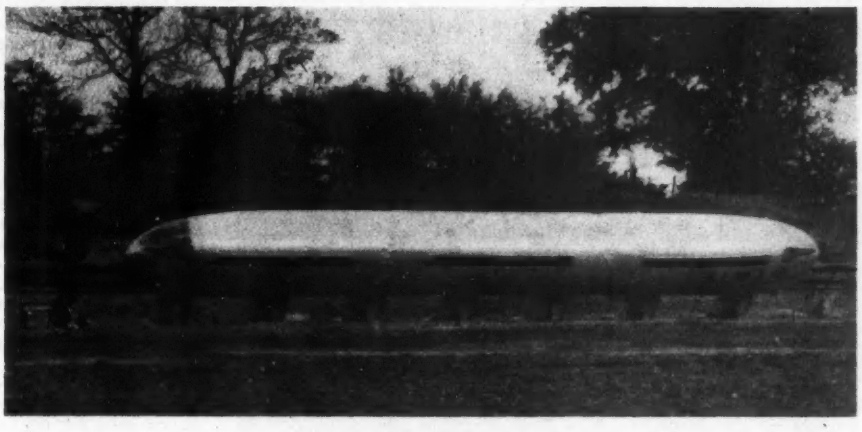
The frame and test gear have been in continuous use for nearly two years and have proved quite manageable by one operator, although the precaution has been taken during most tests of having a second operator at the control panel in case of leaks in the hydraulic system or valves. Maximum loads so far applied have been about 15 tons and they have been measured to a known accuracy of 150 lb, or 2 per cent of the load, whichever is the greater.

The frame was designed originally for experimental work on tapered boxes, which has been done in the civil engineering department of the Imperial College of Science and Technology under the general direction of Professor A. J. S. Pippard. The frame, hydraulic loading gear and linkages cost about £4000. A substantial part of this was contributed by the Department of Scientific and Industrial Research, whose help was much appreciated by the College.

AN INDUSTRIAL CLEANSER FOR HANDS.—We are informed that Borax Consolidated, Ltd., Regis House, King William Street, London, E.C.4, has developed a new hand cleanser known as "Boraxo." This product is stated to contain no insoluble or abrasive fillers and the scouring action necessary to remove ingrained dirt or to penetrate oily films is provided by the small grains of borax, which slowly dissolve during washing. In water solution it is mildly alkaline and does not cause any chemical damage to the skin or remove natural fats.

High-Speed Electric Mono-Railway

IN the course of a recent visit to Western Germany we were invited by the Verkehrsbahn-Studiengesellschaft M.B.H. of 25, Cäcilienstrasse, Cologne, to visit its newly-constructed testing track and railway research station, built on the Fuhlinger Heath, near Cologne, and to see its experimental "Alweg" mono-rail electric train, which began its first official runs in the early days of October. The company was formed close upon a year ago to undertake the design and development of the high-speed mono-railway, for both passenger and goods traffic. Its chairman is Dr. Axel L. Wenner-Gren, of the Swedish Electrolux Company. On the technical side he is supported by the chief engineer, Reichsbahnrat, Dr.-Ing. Hinsken, and the manager and director, Dip-Ing. Georg Holzer. For this work and for future developments a staff of engineers with special experience in aeronautics, road and rail transport has been built up.



Experimental Train

The testing station has a total area of about 120 acres and its main feature is a track raised on short concrete pillars from 1·2m to 3·5m in height, to allow for unevennesses in the site. These pillars support a broad and deep reinforced concrete track girder, which is shown in section in the accompanying drawing. A track switch has been included to allow the train to pass from the sheds to the track. It is electrically operated and a view is reproduced herewith. The track is of oval shape with straight sides and rounded ends. The length of the track is 1700m, and the radius at the ends about 135m. In order to meet safely the forces associated with high speeds up to 300km per hour, it was necessary to bank up the rounded ends to an angle of 45 deg. At these positions the track girder is supported by pillars raked at 45 deg.

In addition to well-equipped engineering workshops there are erecting shops and sheds for the trains. On one side of the site there is a tall control tower with push-button operated controls for train speeds. Below are motor-generators, which are designed to take current from the overhead power lines at 6000V and transform it into d.c. current at varied voltages, to suit the requirements of different European and foreign railway systems.

The new mono-rail system has been named the "Alweg" railway in honour of its sponsor, Dr. Axel L. Wenner-Gren.

THE EXPERIMENTAL TRAIN

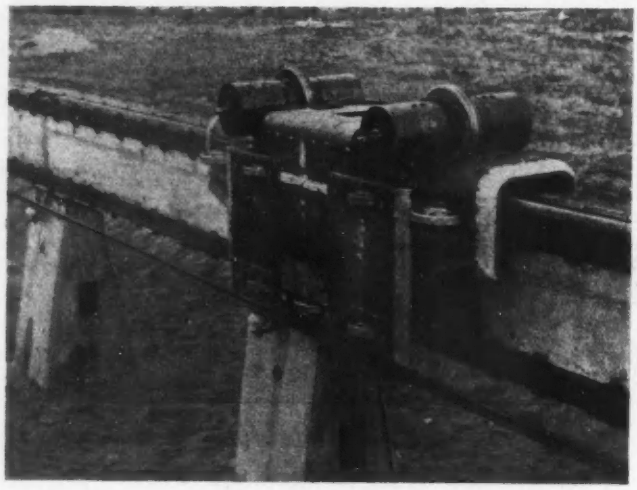
To carry out the first series of experimental runs it was decided to construct a train to the scale of 1 to 2·5 of full size. This train consists of three coaches coupled together. A view of it appears above, taken with the train running on the straight part of the test track. Another view shows the train rounding at speed the end curve at 45 deg. The train is driven by twenty-four 5 h.p. series-wound motors, whose mounting is illustrated on page 872, on the shaft carrying the supporting and driving wheel or roller. The motors are designed for a maximum speed of 2800 r.p.m.

Train on Banked Track

Track Switch

There are two driving bogies to each of the three coaches and therefore the combined motor power of the motors—four to each bogie—is 120 h.p. The drawing showing a section through the carriage and its supporting unit, illustrates the construction adopted. Dealing first with the driving bogie, the saddle form of the supporting structure, which

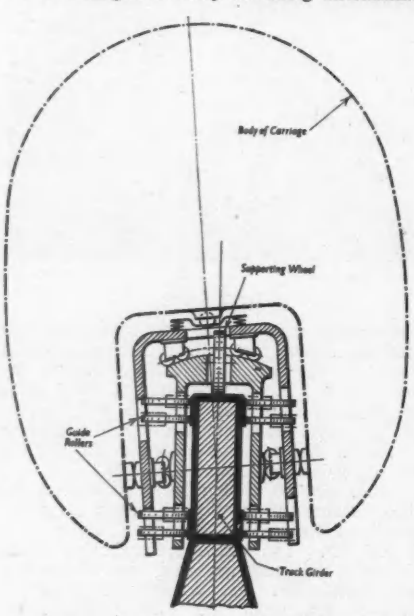
rests on the track girder, will be noted. On the top of the girder is a flat steel plate on which the driving and carrying wheels or rollers run. This plate is mounted on a thin insulating layer, which tends to damp out vertical vibrations. On the sides of the girder are upper and lower thin plate rails, which take the forces from the side guide rollers. There are four guide rollers in an upper group and three rollers in a lower group. Below the lower rollers are the conductor rails on either side, which are carried on insulators. The inner part of the saddle structure houses the carrying, driving and guide rollers, and to the outer part the wagon is attached through spring supports and segmental bearings,



Power Bogie

designed to allow the body to tip slightly on its axis, as indicated in the drawing. The centre of gravity of the system falls below the top of the track girders. The drawing shows the general construction of the coach or wagon body, which is of light aluminium construction, generally similar in character to that used in aeronautical work.

As the photographs of the train show, the three coaches are coupled together, special bellows pattern couplings being employed. The ends of the train are streamlined to reduce wind resistance at high speeds. In the experimental train the coach has a floor immediately above the carrying saddle, which divides the space internally into two halves. The upper half is arranged to carry recording instruments



Diagrammatic Section Through Carriage and Supporting Unit

so that vibrations, static and dynamic loading, &c., can be registered and read by suitable instrumentation. Those who have seen the train under test have commented on the smoothness of running and freedom from undue vibration. In the first run on October 8th, a speed of 130km per hour was reached. Higher speeds have since been recorded and with modifications it is hoped to attain still greater ones.

Full-Scale Train Designs

As soon as the testing programme laid down for the experimental train has been carried out, work is to be pressed forward with a full-size train. It is hoped to test it either on a special track at the testing station or one laid out alongside one of the main railway lines. With this object in view, a complete set of drawings for high-speed electric mono-rail "Alweg" trains has already been completed. There are designs for long-distance trains complete with passenger-cars, dining-cars and sleeping-cars. Freight-cars have also been designed for the carriage of heavy and bulky goods.

Although the experimental trains have conductor rails for taking in the power, which enables the train speed to be regulated from the control tower and not in the train, designs have been prepared for diesel-electric driving, in which the engine-driven generator would be situated in the driving ends of the train and any necessary supplies of fuel oil would be carried in tanks built into the lower parts of the carriage structure.

It was suggested to us that this new development for high-speed travel is not competitive with normal railway practice but will find special applications for long-distance traffic and for elevated railways in crowded towns and cities.

Submarine Marker Buoy

Following trials at sea, the Admiralty has approved a new pattern of marker buoy for Her Majesty's submarines. Light metal construction has been adopted and the buoy, which consists of capsules enclosed in an annular structure, has been designed to combine strength, compactness and sufficient buoyancy to support warning devices. At present a flashing light is installed but the provision of a radio transmitter is being investigated. For its intended service the buoy must be light, strong and small enough to be carried in the submarine superstructure and other requirements are that it must be visible at a reasonable range, remain afloat and attached to the submarine, and transmit a distress signal. Buoyancy is given to the buoy by packing the annular space between the outer and inner drums with 216 watertight, pressure resistant light metal capsules 6in long by 2¼in diameter, while good riding qualities are given by a mild steel stirrup, to which the mooring rope is attached, pivoted on the sides of the buoy. Day-glow special composition which has a high daylight visibility range is applied to the upper surfaces and a ring of twenty-four reflecting road studs is placed on the top, together with a mast carrying a red nylon flag. The light and warning apparatus are fitted within the inner drum and the flashing light unit is housed in a pressure-tight light alloy casting. Two 21 A-h batteries in parallel having a minimum life of forty-two hours, supply the light, which automatically switches itself on and off when the buoy is released.

Blast-Furnace at Kembla Works, New South Wales

A further stage was reached at the end of August in the large expansion programme now in progress in the Australian steel industry with the completion of the new No. 3 blast-furnace at the Kembla Works of Australian Iron and Steel, Ltd. The new blast-furnace, details of which were given in this journal a year ago, is the largest in Australia and, when maximum production has been attained, will add 1500 tons of pig iron per day to the present output at the Kembla Works of 1800 tons per day. Seven thousand tons of steel, 20,000 tons of concrete and 10,000 tons of bricks have been used in its construction. In design, size and productivity it ranks with the largest and most modern blast-furnace operating in any other country and is one of the major projects of the plant extension planned by Australian Iron and Steel, Ltd., in connection with their steel works at Kembla and their adjacent collieries. The plan includes the construction of an additional twenty-four by-product coke ovens, now nearing completion; the building of the two new open-hearth furnaces, the first of which should commence production early in 1953; additional soaking pits; and the installation of a new main electric drive for the bloom mill. When all these plant extensions are completed, Kembla Works' productive capacity will be almost doubled. The increased pig iron output will enable steel production to be improved from the present 14,120 tons per week to 25,000 tons per week, and this increased production will in turn provide raw material for the functioning of the hot strip mill now under construction.

It may well be said that the construction of the new blast-furnace was an international effort. By far the largest proportion of the work was, of course, carried out by Australian workmen, technicians, executives and contractors, and almost every machine shop in Australia has been employed on some part of the work involved. But the technical designs and the drawings, and also the data in connection with the dust cleaning equipment were obtained from United States firms, who contributed greatly to the success of the undertaking. Britain provided much of the electrical and mechanical equipment and Switzerland the blowing engine—a Brown Boveri turbo-blower, one of the largest in the world. When performing the lighting-up ceremony, Mr. Essington Lewis, who until recently was the chairman of the company, referred to the large amount of additional raw material which will be required to feed the furnace each year—760,000 tons of iron ore, which have to be transported to Port Kembla in ships and 500,000 tons of coal. Since 1935, however, when the Australian Iron and Steel, Ltd., amalgamated with the Broken Hill Proprietary Company, millions of pounds have been spent by the two companies in developing their collieries in the Newcastle and Kembla areas and their iron ore mines far afield in Australia. New iron ore deposits have been opened up at Yampi Sound, on the north-west coast of Australia; and at Whyalla, the port of shipment for South Australian ore, a deep-water harbour has been dredged and a shipbuilding yard—the largest in Australia—has been constructed for building the company's own steamers for the transport of iron ore. Later, a shell manufacturing annexe, a tool room and electric steel forge plants were installed at the port. Since the war four vessels of 12,500 deadweight tonnage have been laid down at Whyalla and two of them are already in service. These large vessels have been specially built to the company's own design for the transport of ore from the new deposits in Yampi Sound to the Newcastle and Port Kembla steel works, a round trip of some 6000 miles. The companies have also spent large sums on improving and expanding traffic, power and other facilities, and in developing Rapid Bay, on the eastern shore of St. Vincent's Gulf and 63 miles south of Adelaide, as the main source of supply for the steel industry's limestone requirements. With the planned increase in production at Kembla, Australia's total annual production of steel should be increased to well over 2,250,000 tons.

Gas Turbines for the Royal Navy

SINCE the war the Royal Navy has sponsored the development of gas turbines designed for the main propulsion unit of fast coastal craft. It will be remembered that in 1947 M.G.B. "2009" was the first craft to put to sea with a gas turbine installation and since that time further trials have been carried out and the same vessel, now M.T.B. "5559," was fitted with a Metropolitan-Vickers gas turbine of 2500 s.h.p. coupled to the centre shaft. The tests to which this "Gatric" turbine was subjected for the purpose of burning residual fuels were recorded in the issue of THE ENGINEER of June 29, 1951, and in the same article there was a short description of the harbour launch, H.L. "3964," which was equipped with a small power unit built by the Rover Company.

During this period two engine builders have been concerned with the design and development of two new gas turbines under Admiralty contract. They are Rolls-Royce, Ltd., and Metropolitan-Vickers Electrical Company, Ltd.

"R.M.60" GAS TURBINE

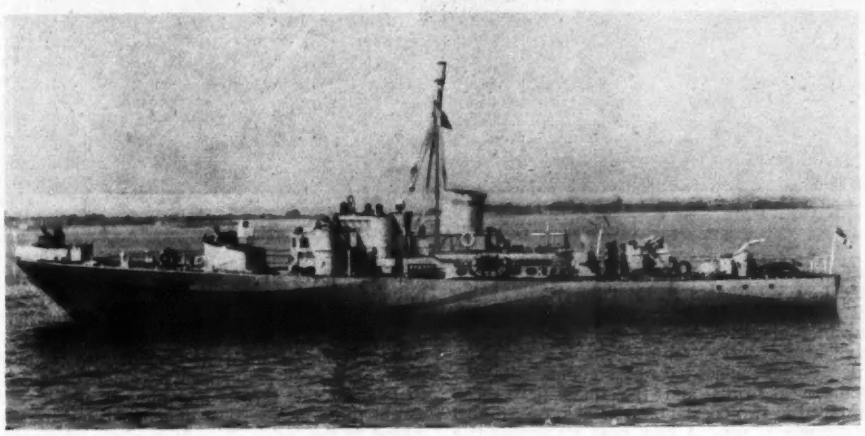
The advantages of applying the experience gained on aircraft gas turbines to units for marine purposes have been fully appreciated by the Admiralty, and as a result Rolls-Royce, Ltd., was asked to make a preliminary exploration of the possibilities. This was done under the direction of the Engineer-in-Chief of the Fleet and after considerable investigation a contract was placed with the company in 1946 for the production of two gas turbine engines for the propulsion of coastal craft. Design work was put in hand at the end of 1947 and by June, 1951, a completed engine was on test. About 90 per cent of the designed power was achieved in the early tests and the engine was run for 220 hours before it was stripped for examination.

Shore trials of the prototype engine, which is designated "R.M.60" and is illustrated herewith, are nearing completion and the two Rolls-Royce power units are to be installed in the gunboat H.M.S. "Grey Goose" in place of the original two sets of steam turbines, each of 4000 s.h.p. It is expected that the installation work will commence early in 1953 and be completed later in the year. The United States Navy have been informed of developments and the United States Navy Department has ordered two prototype engines from Rolls-Royce, Ltd.

Naval requirements for economical low-power cruising called for a high compression ratio, and this has been achieved by multi-stage compression and the use of a heat exchanger, while compression efficiency has been improved further by intercooling after each major stage of compression. The operating cycle consists of a low-pressure compressor delivering air through a sea-water-cooled intercooler to a two-stage centrifugal compressor, which has intercooling between each stage. Air, at maximum cycle pressure, is heated by passing through a heat exchanger before being delivered to the combustion chambers and the fuel is injected and burned in each chamber, the resulting high-temperature gas being expanded through three mechanically independent turbines. The high-pressure turbine drives the high-pressure compressor, and the power turbine drives the propeller through a two-stage reduction gear, while the low-pressure turbine drives the low-pressure compressor. The final drive will be through a "Rotol" three-bladed, variable and reversible pitch propeller which will provide a convenient means of going astern and will allow of variation of engine speed with ship speed to give the best results at a given power. Due to the employment of the mechanically independent turbine, the cycle has the advantage of maintaining economy at low powers and of providing improved engine flexibility.

Many components embody the general principles of the company's aero-engine practice, and this has resulted in a light and compact unit giving a considerable increase in power and a 50 per cent reduction in weight, when compared with the lightest naval steam machinery, coupled with a saving in machinery space. For development purposes the "R.M.60" has been designed for a medium life, but it is expected that operational experience will help to develop gas turbines having a long life between overhauls.

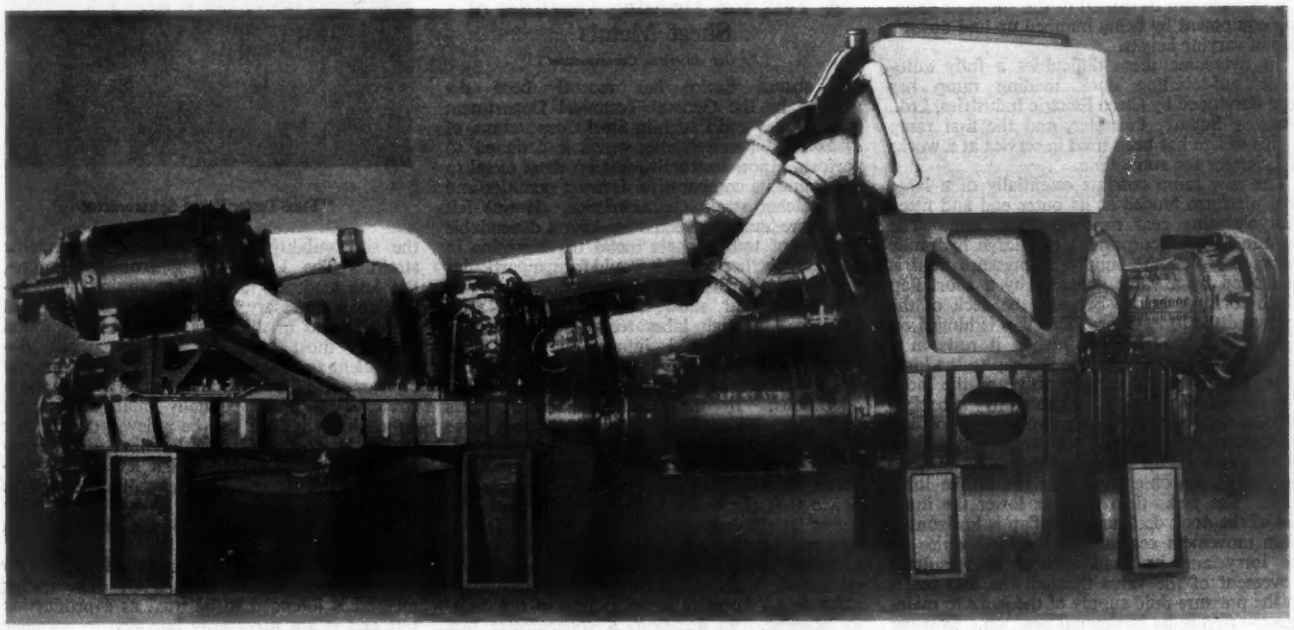
The "Grey Goose," in which the engines are to be installed, is illustrated below, and was built by J. S. White and Co., Ltd., as a steam gunboat. Constructed of steel, the vessel has a length of 146ft, a standard displacement of 205 tons, a speed of 35 knots, and was powered by two 4000 s.h.p. sets of high-efficiency turbines taking steam from a single boiler.



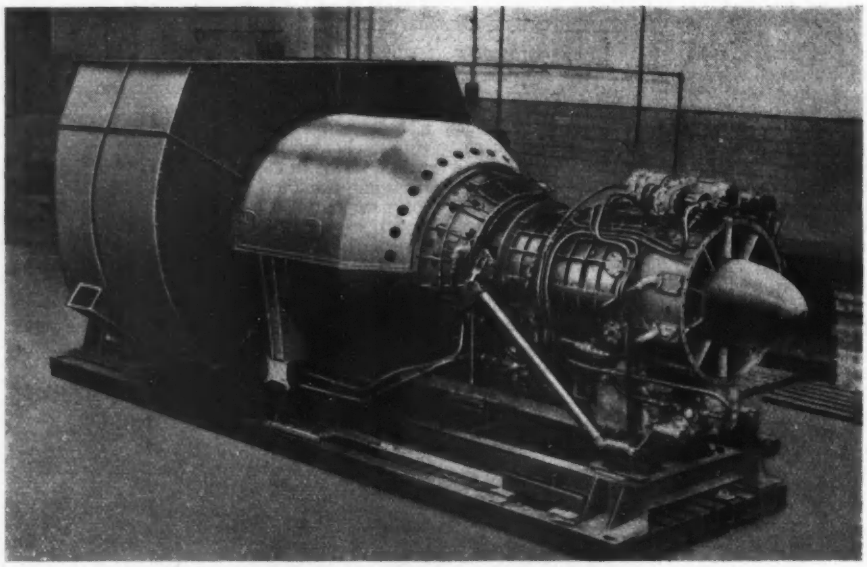
H.M.S. "Grey Goose"

"G.2" GAS TURBINE

As already mentioned, the Metropolitan-Vickers "Gatric" engine was used as a boost power unit in M.T.B. "5559" (formerly M.T.B. "2009"), and following successful sea trials with this unit, the Admiralty placed a contract with Metropolitan-Vickers Electrical Company, Ltd., for the design and construction of four larger gas turbines of improved performance for installation in high-speed craft. The new Mk. "G.2" turbines,



Rolls-Royce "R.M.60" Marine Gas Turbine



Metropolitan-Vickers "G2" Marine Gas Turbine

which we illustrate herewith, develop 4800 h.p. and have been based on the "Beryl" jet engine developed by the company and represent an advance in performance, weight and space as compared with the "Gatric" engine. The shore trials of the engines have been completed at the company's works and the units have been installed in two coastal craft to gain operational experience at sea. A brief note concerning this event appeared in our issue of November 28th. Diesel engines are fitted in the motor torpedo-boats for manœuvring purposes and for cruising at low speed with the gas turbine being available for high-speed running.

A Self-Levelling Loading Dock Ramp

In many industrial establishments difficulties and delays are caused when loading and unloading road vehicles in docks owing to the different levels of the vehicle platforms and the dock floors. Even when using vehicles with a standard platform height, trouble is still experienced owing to the compression or release of the road springs as the load varies. This difference in level often makes double handling necessary or prevents the use of the correct trucks when handling goods loaded on stillages or pallets, and damage can be caused to the goods or handling equipment by being bumped up and down a step of varying height.

To overcome these difficulties a fully automatic self-levelling dock loading ramp has been developed by Cleco Electric Industries, Ltd., Foundry Square, Leicester, and the first ramp to this design has been tried in service at a works in Leicester for some time.

The new ramp consists essentially of a large steel platform hinged at its outer end and fitted with elevating gear near the inner end. The elevating gear incorporates two large hydraulic jacks, to which the supply of pressure fluid is controlled by a valve actuated by a short flap which forms a bridge between the deck of the dock and the lorry floor. This flap is hinged on the edge of the deck and when it rests in a horizontal position to bridge the gap to the lorry floor, the hydraulic control valve of the jacks is in its neutral position. When a lorry is backed into the deck and the flap is swung into position the control valve piston is automatically moved either down or up to admit or release fluid to the jacks according to the height of the lorry floor. The jacks then raise or lower the inner end of the dock deck until the flap is horizontal, when movement ceases. As the load varies on the lorry and its road springs the resultant movement of the valve through the flap reacts on the pressure fluid supply of the jacks to maintain the flap in its horizontal position. In order to prevent damage to the flap and its control gear in the event of the flap being dropped heavily a dashpot is fitted.

The main platform is guided throughout its movement by rollers which move on a massive column let into the foundation of the dock. These rollers run in curved guides designed to take all side thrusts and prevent any loads except those in a vertical direction being transmitted to the jacks. The floor of the platform is built up of heavy steel sections and plates which can easily be removed when it is required to inspect the jacks or control gear set in the pit beneath.

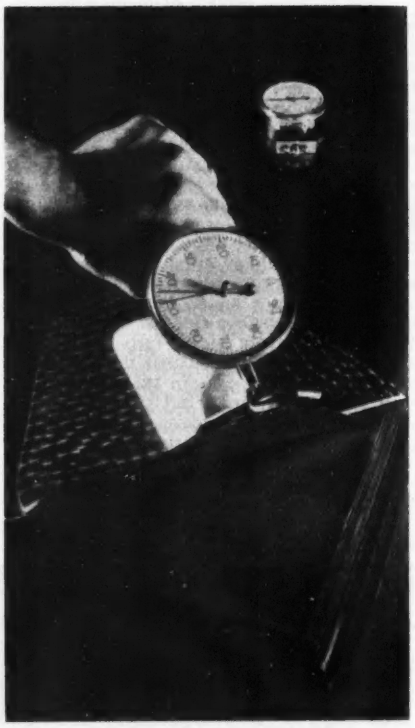
In the course of a recent visit to Leicester we were able to attend a demonstration of this self-levelling ramp in operation in a road dock at the works of Steels and Busks, Ltd. Whilst a lorry standing on the platform was being loaded with pallets handled by trucks, the floor and dock deck level was smoothly and automatically maintained as the road springs of the lorry were compressed. The lorry floor in the normal way would have been about a foot lower than the dock deck, and when the hinged bridge flap was dropped at the outset of the operations, this difference in levels was quickly corrected.

A Test for Drawing Qualities of Sheet Metals

(By Our American Correspondent)

A simple device has recently been developed by the General Technical Department of the Jones and Laughlin Steel Corporation, of Pittsburgh, Pennsylvania, which is designed to perform a non-destructive test on sheet metal to determine its comparative drawing qualities and its stretcher strain characteristics. It was felt that there had long been a need for a dependable method of testing sheet metal to determine in advance whether or not it would form a particular part, and, furthermore, whether or not the material would show stretcher strains after forming. Though laboratory tests have been devised to predict this information, they have tended to be lengthy, expensive, destructive, and often difficult to co-ordinate with production operations. In the past, die setters, press operators and quality control inspectors have often relied on a rule-of-thumb method of bending or flexing the corner of a sheet with their hands before drawing. They knew from experience that the easier a sheet would bend, the better its drawability, and vice versa. It was this practice that led to the development of the so-called "Flex-Tester." The same principle was employed, with the addition of a means of measuring accurately the resistance of the metal to bending. In addition, a spherometer was developed, adapted to measure the diameter of the bend in the sheet, which was found to give an accurate determination of the susceptibility to stretcher strain of the metal during the draw.

The "Flex-Tester," which is illustrated herewith, consists of a rigid steel base bent in a 60 deg. angle. A bracket on the end of the tongue portion serves as a clasp to engage and hold the corner of the material to be tested. An aluminium handle supports a dial indicator, the stem of which rests against the tongue. The device is used to bend the corner of the material through a standard arc, and the dial indicator measures, in *F* units, the resistance of the material to the bending operation. The *F* value is a comparative material resistance quantity compensating for differences in material thickness. To simplify comparisons of the drawing qualities of materials of different thicknesses dial readings are converted to a standard. The *F* values have been established on the basis of 0·035in thickness; if the material is 0·035in no conversion is necessary. For other thicknesses the converted reading is determined by reference to a slide rule. Experience has shown that if the gauge indicates a resistance to flexing of less than 60 *F* units, the steel can be drawn satisfactorily; above 60 *F* units the steel will probably break during a heavy draw. After the sheet has been bent with the aid of the device it retains a permanent set. The spherometer is then used to measure the curvature of this bend, and the *R* value reading obtained gives an indication of



"Flex-Tester" and Spherometer

the susceptibility of the material to stretcher strain. The lower the spherometer reading, the less tendency to stretcher strain. No conversion is necessary for this reading on account of variations in thickness. It has been found that in most cases an *R* value of 30—equivalent to a bend diameter of approximately 3in—or less is required for freedom from stretcher strains. Usually material up to approximately 50 *R* can be relieved of stretcher strains by adequate roller levelling immediately before drawing. If such roller levelling is indicated by the spherometer, a second test can be made, on another corner, after processing to determine the effectiveness of the roller levelling operation.

The "Flex-Tester" has been used successfully on thicknesses up to 16 B.W.G. The testing method is intended to be used as a production test and is not necessarily intended to correlate with any particular laboratory test.

An Electrically Operated Traffic Barrier

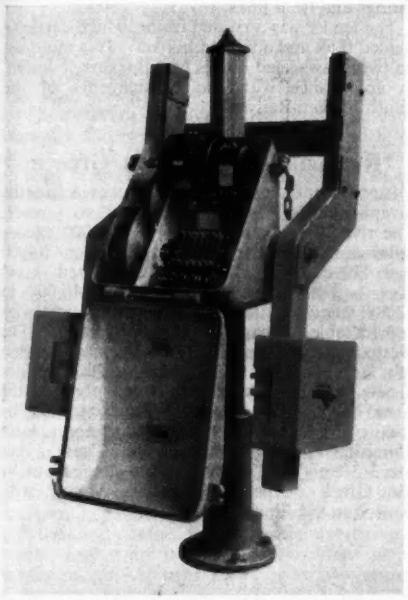
We illustrate herewith an electrically operated traffic barrier mechanism which is in production by the Westinghouse Brake and Signal Company, Ltd., 82, York Way, King's Cross, London, N.1. It is intended to meet the needs of highway crossing protection in countries where the use of gates is not obligatory, and is also useful for the control of road traffic at factory and depot entrances.

It is designed to be carried on a 5½in diameter pipe post, to which the operating mechanism, powered by an electric motor, is rigidly attached. The motor drives the barrier arm from the horizontal to the vertical position, where it is securely held by an electrically operated brake. In the vertical position the arm (which is not shown in the illustration) is completely clear of all road traffic and offers no obstruction.

The arm is counterbalanced but biased to return to the horizontal position when the brake is released, and, during descent, its speed is governed by rheostatic braking. It can be reversed at any time during its descent, and raised again to the vertical position should this be necessary.

The design allows for main barrier arms of lengths up to 38ft and provision is made for the fitting of sidewalk barrier arms when required.

Barriers for export are normally supplied without booms unless they are specially called for : it is thought to be desirable that the booms should be made or obtained locally to facilitate speedy replacement of a damaged boom. To this end it is recommended that booms should be preferably of wood and so constructed that, in the event of damage by a runaway vehicle, the damage will not extend to the barrier



Electrically Operated Traffic Barrier

machine. It is not essential to have a crutch to support the boom in the horizontal position.

Counterweights are fitted to the free ends of the carrier arms, and are adjustable to give the required return effect. Four basic cast iron weights are available, and these, in various combinations, will enable any boom up to 38ft in length to be fitted to the carrier arms. Spring buffers are fitted inside the main case. They are designed to bring the mechanism to rest in the event of the boom being broken off whilst in the horizontal position or the counterweights being broken off whilst the barrier is raised.

A stop on each buffer provides adjustment for the final position of the barrier in the raised and lowered positions. This is made by removing the two covers and adjusting the nuts and screwed rods thus exposed. By this means the horizontal position of the barrier can be aligned from the outside of the machine, and any tendency to "droop" on the part of the boom can be corrected.

A circuit controller is provided in the machine with capacity for a maximum of five circuits in addition to contacts employed in the barrier control circuit.

The main shaft of the machine is driven through a train of gears by a d.c. series motor from a 12V or 24V supply, preferably from a secondary battery ; alternatively, the barrier can be operated by a hand generator, the necessary hold-off current being supplied by primary cells. Both main shaft and motor run on ball bearings, and the idler gear is fitted with a sleeve bearing which can be lubricated. The motor drives the gears through a friction clutch, which is designed to slip when the barrier load would be such as to overload the motor—for example, by deliberately holding down the barrier.

Control of the barrier is by one wire and return. Energisation of the control wire operates the brake magnet, which is fitted with a change-over contact. On picking up, the brake magnet disconnects the snubbing resistance from the motor and connects the motor to line, at the same time applying the brake. The latter acts on the motor shaft through a freewheel so that the motor is free to wind the barrier up, but cannot be driven in the opposite direction. A quick-acting limit switch breaks the motor circuit when the barrier has moved through approximately 85 deg., whereupon the motor slows down. As soon as it comes to rest, it is prevented by the brake from rotating in the opposite direction under the return torque exerted by the boom ; the barrier is thus held with the boom in the vertical position. As the barrier approaches its raised position an economiser contact across the high-resistance portion of the brake magnet winding opens, thus reducing to a minimum the current required to hold the barrier raised.

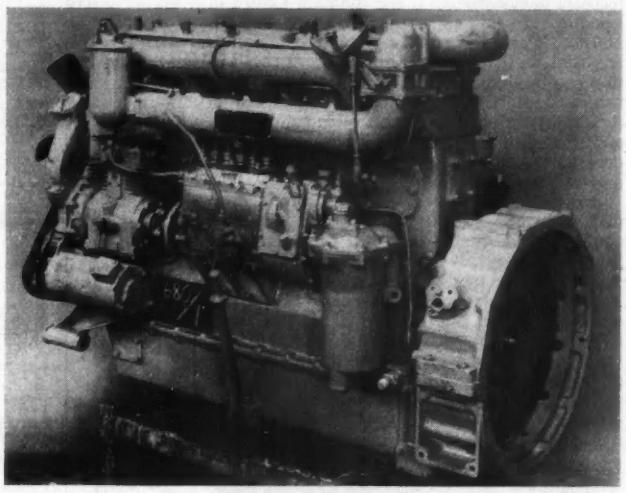
To lower the barrier, the control wire is de-energised, thus releasing the brake and allowing the motor to rotate in the reverse direction as the barrier descends under its own weight. On releasing, the brake magnet change-over contact connects a snubbing resistance across the motor, the value of the resistance being such as to allow the barrier to descend gently under rheostatic braking. The time of descent is adjustable by varying this resistance.

To obtain independence from supply failures, it is recommended that the barrier should be operated from a secondary battery. If a suitable a.c. supply is available, a satisfactory arrangement is to employ a lead-acid battery float charged by a "Westat" constant potential charger. In the event of the supply to the barrier being interrupted, the boom may be raised by hand to allow traffic to pass. Flashing light signals and a warning bell, or other warning devices, can be installed in conjunction with these barriers.

Diesel Engine for Earth Moving Equipment

A 150 h.p. diesel engine of 11·1 litre capacity, designated the "680" engine, is now in production at Leyland Motors, Ltd. In general design it is similar to, and, in fact, is interchangeable with, the Leyland "600" engine, which, since its introduction in 1946, has been noted for its economy in fuel and for easy maintenance. Although the "680" engine is being built on the main assembly line in the company's engine factory at Farington, its production is likely to be limited for some time to come in order that it should not interfere with the output of "600" and "350" engines required for vehicle and industrial purposes.

As its name indicates, the "680" model has a swept volume of 677 cubic inches (11·1 litres), the bore and stroke of its six in-line cylinders being 5in by 5·75in (127mm by 146mm). In general layout the engine is based on a monobloc cylinder and crankcase iron casting in which runs a nitrided crankshaft and gear-driven cam-



150 h.p. Diesel Engine

shaft. Easily renewable dry cylinder liners are fitted and the cylinder head is in two sections, which carry the push rod operated overhead valve mechanism. The power output is 150 b.h.p. at the governed speed of 2000 r.p.m., and the maximum torque is 450 lb-ft at 1100 r.p.m., corresponding to a b.m.e.p. of 100 lb per square inch. At this speed fuel consumption is 0·345 pints per brake horsepower-hour, and even at maximum horsepower rises no higher than 0·38 pints per brake horsepower-hour.

This new engine has been developed to meet the demands of manufacturers of proprietary equipment, mainly earth-moving machinery, for a larger diesel engine. Euclid (Great Britain), Ltd., is one of the companies interested in an engine of this capacity and has already placed orders with Leyland Motors, Ltd., for over 500 of them for its dump trucks. Auto Diesels, Ltd., also requires this size of engine for diesel-electric ground power units which it is building for starting the engines of large aircraft. Wherever it has been possible, the designs staff has limited the external dimensions of the "680" engine to those of the "600" unit. By so doing the new engine can be manufactured by the major portion of the existing special-purpose plant and machine tools installed for the production of the "600" engine. The arrangement will enable the "680" engine to be transferred quickly to large-scale production, when necessary, without incurring large capital costs in new plant. The similarity of dimensions has been pressed to its logical conclusion, so that the "680" conforms to the "600" engine and utilises the same auxiliaries and mountings.

Apart from the increase in the diameter of the cylinder bores, the new cylinder and crankcase casting differs in that it has a new path for the water circulation system. Water now passes from the pump direct into the block for circulation through the cylinder water jackets. After it leaves the block it enters a large cored passage and is then directed through drilled holes into the cylinder heads and on to the nozzle and exhaust valve housings. Although the ¼in difference in the length of stroke over the "600" model has necessitated the use of a new crankshaft and pistons, it has been possible to use the same connecting-rods. The 3 per cent chrome-molybdenum steel crankshaft, which is nitrided, has a ¼in greater throw for the crankpins. The distance from the piston crown to the gudgeon

pin has been reduced by this amount, so that the overall length from the centre line of the crankshaft to the top of the piston at top dead centre remains exactly the same. Other differences include larger valve heads and larger ports.

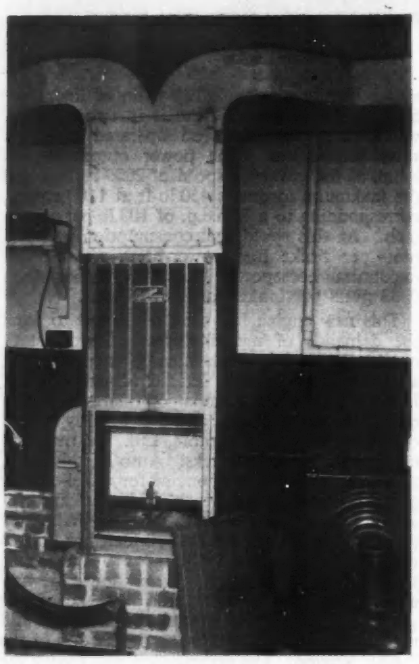
A Gas-Fired Heating System

A NEW gas-fired space heating apparatus for industrial or domestic purposes which has been developed by the Chandos Engineering Company, Ltd., of 17, High Street, Egham, Surrey, was recently demonstrated at the Building Centre in London. In this apparatus the gas is "desulphurised" and the organic sulphur compounds removed, so that the actual products of combustion can be circulated as a clean, healthy heating medium. It is claimed that no heat is lost in the process of removing undesirable compounds, and the only maintenance called for is the occasional replacement of the desulphurising material which is known as "Carbocell."

In one of the photographs we reproduce on this page one of these "Gasanair" heating equipments is shown connected to a system of heating ducts; they are also supplied in smaller cabinet form as unit heaters.

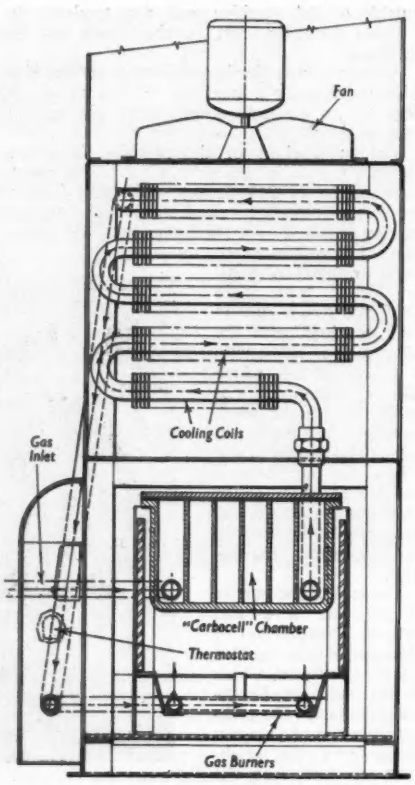
The general construction of one of the heaters and its operation can be followed with reference to the drawing herewith. It should be pointed out before describing the system that the "Carbocell" purifying medium for the gas becomes fully active at temperatures of about 450 deg. Cent.

Gas from the mains is fed to the heater through a normal gas cock and governor and passes



Gas Fired Heating Unit

straight into the "Carbocell" chamber. This chamber is maintained at a temperature of about 500 deg. Cent. and it removes about 70 per cent of the residual sulphur from the gas. The cleaned gas flows up through the tubes of a cooling coil in the rear of the cabinet above. From the top of these coils the gas is piped down through thermostatic control valves and a flame failure switch to the burners. This burner is situated immediately beneath the "Carbocell" chamber, together with which it is enclosed in a heat-resisting insulated chamber. This chamber can clearly be seen in the installation shown in the photograph, where the lower section of grill has been removed. The purified products of combustion from the burners after passing round the "Carbocell" chamber are drawn upwards through the heater cabinet by a fan at the top. The sides of the cabinet are louvred, and the fresh air drawn in through these louvres mixes with the products of combustion to considerably increase their volume before they are discharged



Arrangement of Heating Unit

to the surrounding atmosphere, or passed into ducts leading to the spaces it is required to heat.

No chimney flue for waste products of combustion is required with this heater and only a relatively small floor area is required for its installation. As the "Carbocell" does not undergo any chemical change during the purifying process it does not use up any heat. Such heat as is used to enable the purifier to function is returned to the system when it is cooling off at the end of a heating period.

In hot weather when the heating apparatus is not required it can be converted to a ventilating system and the fan used to circulate cooling air. Alternatively, the fan can be set in reverse to provide an extractor system for a building.

Shunting Locomotives for South African Railways

THE photograph we reproduce below shows one of the new 0–8–0 "S.2" class shunting locomotives which are being built for the South African Railways by Fried. Krupp, of Essen. An order for one hundred of these locomotives was placed with the firm and deliveries began in September last.

These engines are built for the S.A.R. 3ft 6in gauge and their leading particulars are as follows:—

Cylinders, diameter and stroke	18in by 26in
Rigid wheel base	12ft 9in
Total wheel base	12ft 9in
Diameter of driving wheels	4ft
Boiler pressure	195 lb per square inch
Grate surface	30 square feet
Evaporative heating surface	1064 square feet
Heating surface of superheater	330 square feet
Service weight	52 tons
Minimum curve	175ft
Maximum speed	25 m.p.h.
Tractive effort at 75 per cent boiler pressure	25,600 lb
Tender:	
Water capacity	4200 Imperial gallons
Coal capacity	8 tons
Diameter of wheels	2ft 10in
Rigid wheel base	8ft 8in
Total wheel base	24ft 7½in
Service weight	54 tons

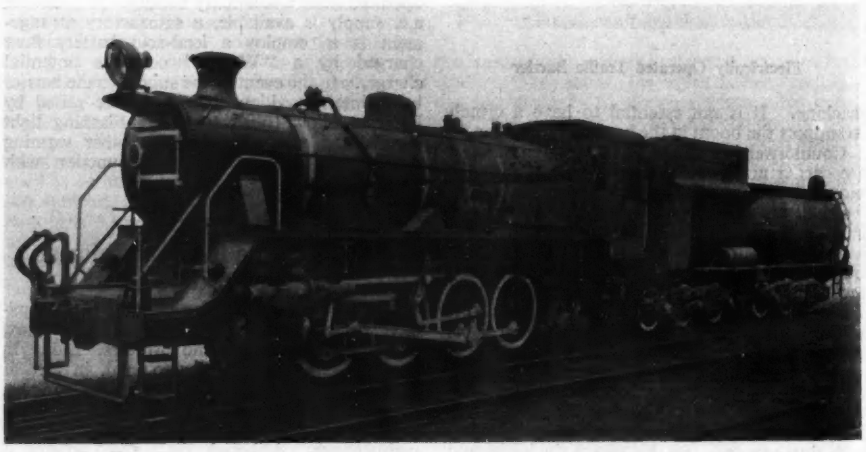
The boilers are of welded construction throughout. For test purposes ten of the locomotives are fitted with boilers in which the water space and crown stays are welded in with allowance for play, and they have steel fireboxes welded into the firebox shell crown. A special grate for hard coal firing is fitted with a steam-operated rocking grate and a hand-operated drop section. The ashpan is fitted to the locomotive frame, and air is admitted through a free space between the ashpan and a foundation ring connecting the firebox and firebox shell.

The two rolled bar frame plates of the locomotive are 3½in thick and are connected by rigid steel castings. A divided saddle cylinder of cast iron is fitted with cast liners. A Walschaerts-Heusinger valve gear is fitted to the forward and reverse motion as well, as the degrees of cut-off are obtained through a steam reversing gear. All revolving weights are balanced and about 33 per cent of the reciprocating weights. The frame is supported on the axles by two groups of springs and fixed links.

The tender has a riveted frame, which carries a welded tank and a riveted bunker. It is mounted on two six-wheeled bogies of "Buckeye" design, in accordance with the requirements of the South African Railways.

Reclamation Works in Greece

IMPORTANT Greek reclamation works include the diversion of the Nestos River in Northern Greece. The river has a catchment area of 2000 square miles and a discharge varying between 70,000 and 430 cusecs. The natural river bed, however, had a capacity of only about 10,000 to 13,500 cusecs, so that flooding was frequent with considerable damage to cultivated land. The Nestos River scheme includes the construction of a large dam and the diversion of the river into a new bed excavated at the lowest point of the river delta. Floods are to be controlled by means of two parallel dykes, 2600ft apart, built alongside the diversion channel. These dykes are 3·3ft high. The works were carried out by the Greek Ministry of Public Works, with American aid funds.



0-8-0 Shunting Locomotive for South African Railways

Industrial and Labour Notes

Coal Miners' Wages

At a delegate conference of the National Union of Mineworkers, which was held in London on Thursday of last week, a resolution was passed rejecting an offer from the National Coal Board of an increase of 6s. a week for day-wage men on the minimum rate. A condition attached to the Board's offer was that piecework rates should be stabilised for a further year and that a guarantee should be given to continue Saturday working next year. It is understood that the offer made by the Coal Board would bring the weekly minimum wage to £6 7s. 6d. for men on the surface and £7 6s. 6d. for underground workers, there being proportionate increases for juveniles. Following the resolution, the conference instructed the union's executive committee to intensify its negotiations with the Coal Board to obtain new national rates for day-wage men without delay. According to a statement made afterwards by Mr. Arthur Horner, the secretary of the union, a decision on Saturday working is to be taken in the New Year.

Area Pattern of United Kingdom Trade

In a statement about the area pattern of United Kingdom trade during October, the Board of Trade says that the main point of interest was the sharp increase in the value of exports of £27,000,000, or 14 per cent, compared with the monthly average for the third quarter. It is pointed out, however, that such an increase is normal following the effects of the holiday season. The daily rate of export in October was still 5 per cent below the average for the second quarter of the year. In October exports to the dollar area accounted for £9,000,000 of the increase over the third quarter's average, while £12,000,000 was in shipments to the sterling area, and £6,000,000 to non-sterling O.E.E.C. countries and possessions. Exports to the rest of the non-sterling world—which declined substantially during the third quarter—showed little change during October. By contrast, there was no large change in imports in October, either in the total value or in the area pattern. Re-exports in October increased by £2,000,000, mostly to non-sterling countries.

The excess of imports over total exports in October, for the United Kingdom's trade with all countries, was down to £36,000,000, compared with £61,000,000 a month in the third quarter, although the Board of Trade says that " no great significance should be attached to one month's figures in that connection." In the second half of the year to the end of October, the trade deficit with all countries averaged £55,000,000 a month, compared with £78,000,000 in the first half of this year and £101,000,000 a month last year. The statement goes on to say that the progressive improvement has been in trade with non-sterling countries, particularly with O.E.E.C. countries and possessions and with the remaining non-sterling countries outside the dollar area, but the second half of this year has shown a substantial reduction in the trade deficit with the dollar area. As far as trade with the sterling area is concerned, imports this year have been much the same as in 1951 ; but, except in the early months of the year, exports have been much lower.

Export Development

Speaking at the annual banquet of the Institute of Export, in London on December 17th, the Chancellor of the Exchequer, Mr. R. A. Butler, said that even in this difficult year we had been exporting a volume of goods more than 50 per cent larger than in 1938, and if that had happened in the ordinary course of things this country would indeed have been well off. But after a war that had cost a quarter of our national wealth, " we had to run fast just to stay in the same place," though we had been changing our make-up as we ran.

Nevertheless, Mr. Butler continued, the mills and the mines still had an important part to play in our foreign trade. The demand for engineering products was not only weighty, but widespread. In 1935 a quarter of our national industrial output was in metals and metal goods, but now it was more than one-third ; the same industries had contributed 37 per cent of the country's exports in 1938, but last year's contribution was 46 per cent of a total two-thirds larger. Most of those metal exports, the Chancellor added, were capital goods for development schemes in all parts of the world, and not least in the Commonwealth. Each Commonwealth country had to find resources for its own development, but this country had the double task of finding both finance and physical equipment to assist them. The significance of the dependence of Commonwealth countries on British factories was brought out by the single fact that over half their engineering imports came from this country, and for some of them the proportion was three-quarters.

The Chancellor went on to say that this country must continue, in a double sense, its search for new work. Attention must be given to countries which we had cultivated little in the past and to new kinds of exports for which there was a demand or for which one could be created by skilful marketing. Any product, technique or sales method that contained the promise of expanded export sales needed to be examined in industry with all possible care. The Government, for its part, would certainly study with care any method proposed to it for the encouragement of exports. Since the end of the war, the Chancellor observed, the target for exports had been to enable the country to pay its way. Now, seeing matters in clearer perspective, and having by effort in the last year secured the opportunity to take a longer view, the need to set the sights higher was realised.

Iron and Steel Consumers' Council

The Iron and Steel Consumers' Council—which was set up in July, 1951, under the Iron and Steel Act, 1949—has just presented its first report to the Minister of Supply. The report covers the period July, 1951, to September 30, 1952, during which the Council held five meetings and received five representations from consumers.

Dealing with steel supply and demand, the report refers to the allocation scheme which was introduced in February last, and notes that the expectation for this year is that total supplies, production and imports combined, of steel ingots and castings will amount to about 18,000,000 tons, compared with less than 16,250,000 tons last year. The report goes on to deal with prices, commenting that the present system of calculating the maximum prices for iron and steel is largely based on recommendations made by the Iron and Steel Board of 1946–48. The object of price control, the report says, is doubtless to keep prices at a reasonable level while providing a fair profit for the steel maker, and the Council has no hesitation in saying that in present circumstances price control is essential. But, it is added, the Council is impressed with the difficulties occasioned by price changes, and has suggested to the Ministry of Supply that frequent changes should be avoided especially where they are small.

Among the representations received by the Council in the period covered by the report was one from various steel consuming interests in Scotland, which was made at the beginning of this year. The complaint was that supplies of steel were worse in Scotland than in England, and it was suggested that a larger share of scrap should be diverted to Scottish steel makers, or that an increased share of English steel output capacity should be allocated to Scottish steel consumers. The report says that the Council has ascertained that the British Iron and Steel Federation has been doing all that it can to help. Pig iron production in Scotland has been substantially increased and a high proportion of the imported scrap is being directed to Scotland, which is also receiving a handsome share of American ingot steel. Whilst feeling that every practicable step is being taken to solve the problem and noting that there has been a marked improvement in the position since the complaint was first made, the Council says that it will " continue to watch the situation."

Industrial Production

According to an analysis published in *Bulletin for Industry*, a review of the economic situation which is prepared monthly by the Treasury, total industrial production in this country in the first ten months of the year was 3 per cent below the figure for the corresponding period of last year. In the first quarter of this year it was at the figure which had been roughly maintained—apart from holiday periods—since the autumn of 1950, but from April a fall occurred, so that in the third quarter the gap between this year and last was about 6 per cent. The preliminary estimate for October, however, suggests that the overall index may be back to last year's level.

Among the main factors in these changes in trend, the *Bulletin* puts first the shortage of raw materials, which appeared fairly early last year, but which difficulty is now fast disappearing. Other factors influencing the level of output for the first time to any appreciable extent for several years were, from the middle of last year, a contraction of demand at home and abroad. Raw material shortages, particularly of steel, certain non-ferrous metals, and sulphur, the *Bulletin* says, hampered expansion notably in the metal-using industries and led to a fall particularly in the output of motor vehicles. Output in these industries was further affected by the need to divert resources to defence, a matter which caused some dislocation last year. In spite of these difficulties, however, production in the metal, engineering and vehicles group of industries as a whole increased during 1951, although at a slower rate than in preceding years, and in the first half of this year output was 3 per cent up on the first half of 1951. Within the total, ferrous and non-ferrous metals were higher than a year earlier, and so was production in the engineering industries, although there has been a decline in the output of electrical consumer goods.

Fellowship in Management Accountancy

The Institute of Cost and Works Accountants has announced the establishment of a Fellowship in Management Accountancy, and has published some details of the first examination for the Fellowship, which will be held in December, 1953. Thereafter the examination will take place during the second week in June in each subsequent year. The Fellowship is open to associates of the Institute of Cost and Works Accountants and to members of the Institute of Chartered Accountants of Scotland, the Institute of Chartered Accountants in England and Wales, the Society of Incorporated Accountants and Auditors, the Institute of Chartered Accountants in Ireland, the Association of Certified and Corporate Accountants, the Institute of Municipal Treasurers and Accountants, and certain overseas bodies of accountants.

Speaking last week about the establishment of the Fellowship, the president of the Institute, Mr. S. C. Tyrrell, said that it represented a significant advance in the accounting world and that directors of companies would be particularly interested, as the Fellowship would be the highest qualification obtainable for management accountancy in all its aspects. No substitute for the assessment of the character of a man by his prospective employer had yet been found, nor was it ever likely to be found, as only experience, acumen and a flair for the management of men could give that ability to assess character. But, Mr. Tyrrell asserted, the new qualification would provide directors and others with reliable proof of the applicant's knowledge of his job and a measure of his practical experience. Whilst the final and acid test of suitability must always remain character and personality, the qualification of Fellowship of the Institute would undoubtedly save a great deal of preliminary investigation and remove many doubts.

Notes and Memoranda

Air and Water

COASTAL MINESWEEPER.—Her Majesty's coastal minesweeper "Coniston," which was launched from the yard of John I. Thornycroft in July last, carried out her trials successfully on December 15th and is the first of her class to do so.

H.M.S. "CHILLINGHAM."—The inshore minesweeper H.M.S. "Chillingham" was launched from the shipyard of Hugh McLean and Sons, Ltd., Renfrew, on December 19th. The vessel, which has a length of 106ft 5in by 20ft 6in beam and carries one small gun, will have machinery supplied by Davey, Paxman and Co., Ltd.

P. AND O. COMMODORE.—Captain S. W. S. Dickson, who joined the P. and O. line in 1914 and has served in a number of ships, including the "Viceroy of India," "Strathnaver," and "Stratheden," and is now in command of the "Himalaya," has been appointed as commodore of the P. and O. fleet in succession to Captain H. S. Allan.

MARINE AUXILIARY SET.—A new marine auxiliary set has been produced by A. C. Morrison (Engineers), Ltd., which has an output of 28·5kW, 110V d.c. and overall measurements of 7ft 3in by 2ft 7in by 5ft 1in. The set, of which eight have been supplied to the Turkish Navy as auxiliary power units in corvettes, is powered by a "Porpoise" diesel engine, supplied by Parsons Engineering Company, Ltd. It is a marine version of the Meadows "330" automotive engine.

CHARTING OF NORFOLK BROADS.—A complete new survey of the Norfolk Broads and the rivers Yare, Bure and Waveney is being carried out by Hamilton's Publications, sponsored by Mr. H. Collins and Mr. G. Money, compilers and publishers of the Broads charts. The last survey was made eighteen years ago, and the present survey is being made with the aid of a Marconi marine "Seagraph" echometer, specially modified for shallow sounding work. This equipment is installed in the motor cruiser "Elsinore II," which travels at 4 knots, while the echometer produces a contour graph of the bed of the Broads to depths as shallow as 2ft and also indicates whether the bottom is hard or soft. When complete, 250 miles of the Broads will have been charted and the new charts will be published in the 1953 edition of *Hamilton's Charts and Index*.

Miscellanea

BUSINESS EFFICIENCY EXHIBITION.—The next Business Efficiency Exhibition, which will open at Olympia on June 16, 1953, is expected to be the largest yet held. More than eighty firms are expected to participate, and a series of composite special features are being prepared which will reveal the extending field of activity in which the industry is operating.

TRAINING SCHEME FOR FOREMEN.—Hadfields, Ltd., announces that it is introducing a new scheme for the further intensive training of foremen. Tuition will be given on such subjects as work study, productivity, quality control, the conservation of man-power, materials and of machine tools. The object of this innovation is to make foremen more familiar with the overall activities of the company and of departments other than those which they themselves control.

ZINC CONTROL ENDS.—The Minister of Supply announces that from January 1, 1953, the provisions of the Copper, Lead and Zinc Distribution Order, 1951, will cease to apply to zinc. The removal of this control means that licences will no longer be required for the purchase or sale of zinc; it arises from the decision, already announced, to reopen the London Metal Exchange on January 2, 1953. Lead was decontrolled in October last, and licences are now only required for the purchase of copper.

BRITISH SCIENTIFIC BOOK EXHIBITION IN BURMA.—An exhibition of scientific books and novels has been sent to Burma by the British Council for showing in Rangoon in late January or early February. It is hoped to show the exhibition in several other centres in Malaya. The scientific sections are sociology, including economics, social welfare, politics and history; medicine, including tropical medicine, hygiene and nursing and hospital administration; engineering, applied science and technology, and agriculture.

INSTITUTE OF METALS MEDALS.—The Council of the Institute of Metals has awarded its Platinum Medal for 1953 to Professor Georg Masing, of the Institut fur Allgemeine Metallkunde, Universitat Göttingen, in recognition of his outstanding contributions in the field of metallography. The Rosenhain Medal for 1953 has been awarded to Dr. Charles Eric Ransley, of the research laboratories, The British Aluminium Company, Ltd., Gerrards Cross, in recognition of his outstanding experimental and theoretical work on gas-metal equilibria.

IRON AND STEEL ENGINEERS' MEETING.—The next meeting of the Iron and Steel Engineers Group of the Iron and Steel Institute will be held jointly with the plant engineering and steel making divisions of the British Iron and Steel Research Association on Wednesday, January 21, 1953. This meeting will take place at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1, and will be devoted to the discussion of four papers on "The Maintenance and Repair of Open-Hearth Furnaces." At the morning session, beginning at 9.30 a.m., two papers will be presented dealing with British practice, and at the afternoon session, beginning at 1.30 p.m., there are to be two papers on overseas practice. A buffet luncheon will be available from noon until 1.30 p.m.

THE BRITISH INDUSTRIES FAIR.—Last week the President of the Board of Trade was asked in the House of Commons whether he would consider the division of the British Industries Fair, due to be held in 1954, into smaller specialised shows, in view of the increasing importance of the show to the nation's economic welfare. The President replied that no major change was contemplated for the 1954 Fair, but an Exhibitions Advisory Committee had been asked to advise on the arrangements in the longer term.

NEW FACTORIES IN LANCASHIRE.—The President of the Board of Trade was recently asked the total number of factories completed in England in the years 1950, 1951 and 1952 to date and the number of those which were erected in Lancashire. A table which was given in the President's reply dealt with projects of more than 5000 square feet, and showed that from January 1, 1950, to September 30, 1952, of the 2408 factories totalling 47·7 million square feet erected in England, 352 totalling 7·6 million square feet were in Lancashire.

COMMONWEALTH TRADE STATISTICS.—The latest *Statistical Abstract for the Commonwealth*, covering the trade of the Commonwealth in the years 1948–1951, has been published for the Board of Trade by H.M. Stationery Office (price 15s.). The figures in the main cover only these years, but in the summary tables showing the trade and direction of trade of the Commonwealth as a whole, figures are given for the first six months of the present year. Summary tables also show the direction of trade of the sterling area. In addition to the summary tables, the volume contains a detailed analysis of the trade of the independent members of the Commonwealth and of virtually all the Colonial territories.

THE USE OF COPPER AND COPPER ALLOYS.—Orders have been made by the Board of Trade revoking the Copper and Zinc Prohibited Uses (Board of Trade) Order, 1951, as amended, and the Copper and Zinc Prohibited Uses (Ministry of Supply) Order, 1951, as amended. The new Orders came into operation on December 18th. The effect of them is to remove restrictions which have been in operation since early in 1951 on the use of copper, brass and other copper alloys in manufactures for the home market. Restrictions on alloys which contain nickel will continue; their use is still prohibited by the Nickel Prohibited Uses (Board of Trade) Order, 1951, as amended, and the Nickel Prohibited Uses (Ministry of Supply) Order, 1951, as amended.

INSTITUTION OF THE RUBBER INDUSTRY.—The Colwyn Gold Medal for conspicuous scientific services to the rubber industry was presented by Sir Clive Baillieu, president of the Institution of the Rubber Industry, at the annual dinner of the Institution in London, on December 11th, to Dr. Geoffrey Gee, director of the British Rubber Producers' Association, who has been made a Fellow of the Royal Society for his major contributions to rubber science. The Hancock Gold Medal, which is awarded for services to the industry not necessarily of a scientific nature, was presented to Dr. T. J. Drakeley, principal of the Northern Polytechnic since 1931, who in 1924 established the world's first rubber trade school and has been mainly responsible for setting up the National College of Rubber Technology, of which he is the director.

MOND NICKEL FELLOWSHIPS.—The Mond Nickel Fellowships Committee has made awards for 1952 as follows:—To Mr. A. G. Duce (Joseph Lucas (Gas Turbine Equipment), Ltd.) to study in the United Kingdom, the Continent, U.S.A. and Canada the metallurgy and testing of materials, especially in sheet form, developed for high-temperature service, and the techniques employed in the manufacture of the combustion systems of gas turbine blades; to Mr. F. G. Horton (National Foundry College), to study casting production methods in the United Kingdom and on the Continent, with special reference to shell moulding, centrifugal casting, and sand-cement moulding; to Mr. H. A. Longden (Steel Peech and Tozer, Ltd.), to study metallurgical control methods in the United Kingdom, on the Continent, the U.S.A. and Canada, with special reference to open-hearth slag and temperature control; and to Mr. G. P. Kempson (Henry Wiggin and Co., Ltd.), to study the development, application and control of ferrous and non-ferrous melting and ingot casting processes in the United Kingdom, on the Continent, the U.S.A. and Canada.

MOULDED NYLON.—We are informed by British Ropes, Ltd., of Doncaster, that it is now manufacturing moulded nylon products for a wide range of industrial applications at its plastics department in Leith, which has specialised in the moulding of nylon for the past three years. It is pointed out that this thermoplastic material can be reheated and reshaped repeatedly, although some of its physical properties are affected if recycling is carried out too frequently. Whereas most thermosetting plastics have a service temperature of about 180 deg. Fah., nylon does not soften below 300 deg. Fah. and it melts at temperatures above 480 deg. Fah., which is generally higher than the charring point of most thermosetting materials. It has good physical and mechanical properties, being extremely tough, resistant to abrasion, light, highly resistant to chemicals, non-inflammable, and having a low coefficient of friction. Nylon gears have been found particularly good in many applications, particularly where vibration-free, silent running is essential. The firm produces nylon components by injection moulding, and states that, providing the quantities to be produced justify the initial mould cost, moulded nylon parts compare favourably in price with metal items which require individual machining operations.

PRODUCTS OF THE BRITISH COLONIAL TERRITORIES.—The eighth volume of the *Economic Survey of the Colonial Territories*, which has just been published, shows that two-thirds of the world supply of tin and over a third of the world supply of rubber come from Malaya; one-fifth of the world production of bauxite for aluminium comes from British Guiana; nearly half of all production for sisal for cordage comes from British East Africa; Northern Rhodesia ranks third amongst world producers of copper; the Gold Coast is the world's largest exporter of manganese—15 per cent of the total output; and Nigeria produces almost all of the world's output of niobium.

FREE TRADING IN ZINC.—The Ministry of Materials announces that it has now completed its discussions with the trade on arrangements for the release of zinc from its stocks during the first seven months of private trading after January 1st next. The Ministry has agreed to sell back to the agents of the United Kingdom and other Commonwealth producers 24,000 tons of zinc of their own brands. This metal will be available for immediate delivery as required throughout the first half of next year. Adequate supplies will therefore be available to meet consumers' requirements. No other zinc from the Ministry's stock will be placed on the market during this period, except for sales by the Government broker on the London Metal Exchange for prompt delivery when no other prompt supplies are available. Pricing of the 24,000 tons of zinc will be on the basis of the monthly average London Metal Exchange quotation over the six months from February to July, 1953, at the rate of 4000 tons per month. None of this zinc will therefore be priced during the first month of free trading. It has been agreed that there will be further discussions between the Ministry and the parties concerned if in the light of experience modification in these arrangements appears to be called for.

THE COMBUSTION ENGINEERING ASSOCIATION.—We have received from the Combustion Engineering Association a copy of the book *Firing Equipments and Their Fuels*, Section 1, "Shell Boilers Fired by Solid Fuel." This manual has been prepared by the Association at the request of the Ministry of Fuel and Power as a guide to users and potential users of mechanical stoking appliances. The general principles of stoker operation are enumerated and 12 per cent given as the CO_2 figure to be maintained at the boiler exit, while there are brief descriptions of four mechanical stokers, namely, the sprinkler stoker, the coking stoker, the underfeed stoker, and the chain and travelling grate stokers. Fuels are generally considered, one section deals with coals and another refers to coke and coke breeze. The remainder of the manual consists of tables, preceded by explanatory notes, which specify the coals for individual designs of stoker in association with an N.C.B. group number by indicating which fuel is recommended, acceptable, or not advised for use. Included in the tables are the ash and moisture contents and the sizes of smalls for the recommended and acceptable coals. Copies of the book are obtainable from the Association, 6, Duke Street, St. James's, London, S.W.1, price 10s.

Personal and Business

CAPTAIN R. T. PAUL, C.B.E., R.N. (Ret.), A.M.I.E.E., has been appointed commercial manager in the equipment division of Mullard, Ltd.

MR. G. T. SHOOSMITH, M.I.C.E., M.I.Mech.E., has resigned his position as engineer of Wm. Cory and Son, Ltd., to become joint managing director of Plenty and Son, Ltd., Newbury.

MR. MAXWELL WOOSNAM has been appointed vice-chairman of Richardsons Westgarth and Co., Ltd. Mr. A. Kinsman and Mr. R. M. Atkinson have been appointed directors of the company.

ALEXANDER DUCKHAM AND CO., Ltd., states that the address of its head office and sales department is now at Hammersmith, London, W.6 (telephone, Fulham 3300; telegrams, "Adcoidise, Wesphone, London").

THE INTERNATIONAL HARVESTER COMPANY, Chicago, has acquired the stock of The Frank G. Hough Company, Libertyville, Illinois, manufacturers of earth-moving, excavating and materials handling equipment.

THE POWER PLANT COMPANY, Ltd., West Drayton, Middlesex, announces the retirement of Mr. S. B. Haslam, M.I.Mech.E., M.I.E.E., its agent in South Wales. Mr. G. H. Pearson, A.M.I.Mech.E., 56, Bridge Street, Newport, Mon., has been appointed to succeed him.

MATERIALS HANDLING EQUIPMENT (GREAT BRITAIN), Ltd., 7, Chesterfield Gardens, London, W.1, states that it has been appointed export agent for the "Timber Wolf" straddle carrier by Pest Control, Ltd., and for the Merton overhead loader by the Merton Engineering Company, Ltd.

VICKERS, Ltd., announces that for reasons of health Mr. A. J. Palmer, C.B.E., is vacating his seat on the board. He also retires from the boards of Vickers-Armstrongs, Ltd., and other companies in the group. Mr. Palmer joined Vickers, Ltd., in December, 1912. He was appointed to the board of Vickers-Armstrongs, Ltd., in August, 1940, and to the board of the parent company in 1950.

THE BRITISH ELECTRICITY AUTHORITY states that Mr. William Casson, M.I.E.E., technical engineer in the Eastern Division, has been appointed system design and development engineer in the transmission design branch at headquarters. The B.E.A. also announces the appointment of Mr. D. C. Thomson, M.A., as Director of Welfare in succession to Mr. J. W. Thomas, who retired in September.

British Patent Specifications

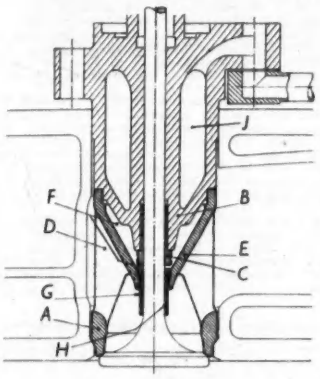
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2. 2s. 8d. each.

INTERNAL COMBUSTION ENGINES

682,448. May 10, 1949.—PROTECTING EXHAUST VALVES OF INTERNAL COMBUSTION ENGINES, Societe D'Etudes de Machines Thermiques, 7, rue Auber, Paris, France.

The invention comprises a sleeve closely surrounding the valve stem with a screening member attached to it. In the drawing the exhaust valve is seated on a removable seat *A* mounted in the cylinder head. The valve guide *B* is provided with a removable sleeve *C*. Spacer arms are shown at *D*. A hollow

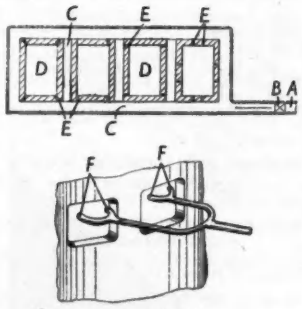


No. 682,448

frusto-conical bushing or screening member *E* separated from the valve guide by an air space *F* is mounted on the valve guide *B* at a point remote from the valve stem, and carries at its apex a valve stem protecting sleeve *G* separated from the valve stem by a space *H*. The point of support is in the proximity of the chamber *J* of the valve guide. The hollowing of the bushing member *E* is such as to provide for a substantial air space *F* between the bush and the valve guide. This space acts as a heat-insulating chamber and separates the sleeves *C* and *G*. The sleeve *G* will be directly heated by the exhaust gases and heat transmission by conduction from the sleeve will only be possible through bush *E* to the valve guide because of the air chamber *F*. The heat transmission by conduction will depend upon the cross section of the walls of bush *E* and the position of the supporting connection near the chamber *J*. The sleeve *G* shrouds a considerable length of the valve stem, the protection of which therefore, especially of that part which enters the sleeve *C*, will be particularly effective. A modified design for valves directly seated in the cylinder head is also shown in the specification.—*November* 12, 1952.

682,641. October 30, 1950.—TWO-STROKE CYCLE ENGINES, Crossley Brothers, Ltd., Openshaw, Manchester, 11, and Herbert Desmond Carter, of the company's address.

The object of the invention is to provide simple and effective means which reduces carbon formation in the exhaust ports to a minimum and disperses any carbon which may have formed. In the drawing,

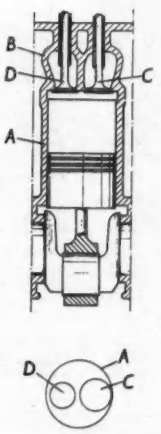


No. 682,641

air, which may be obtained from the scavenge manifold, is delivered by a pipe *A* past a non-return valve at *B* to channels *C* which may be formed in a cylinder liner around the exhaust ports *D*. Holes *E* drilled in the exhaust port walls cause such air to be projected into the exhaust ports whilst the engine is running normally. The air acts as a blanket and disperses any carbon which may form on the port walls and prevents or minimises the formation of carbon deposits. The bore of the engine cylinder block closes the channels *C*. Various arrangements of the holes *E* are possible, and four arrangements are shown in the drawing. It will be understood that any of these arrangements may be used in all the ports. In the lower view, nozzles *F* direct air jets into the exhaust ports of a single cylinder of an engine so that the air impinges on the port walls or port bars. The invention is not limited by any particular arrangement of air passages and air ports or nozzles for accomplishing its purpose.—*November* 12, 1952.

683,113. May 2, 1951.—SQUARE OR OVER-SQUARE FOUR-STROKE ENGINES, Daimler-Benz Aktiengesellschaft, Stuttgart-Untertürkheim, Germany.

The invention relates to improvements in square or over-square internal combustion engines, particularly four-stroke engines. As will be seen from the drawing, the engine cylinder and crankcase block *A* and the cylinder head *B* are one casting. In the cylinder head the relatively large inlet valve *C* and the smaller exhaust valve *D* are situated in a suspended arrangement such that the valves are within the periphery of the cylinder. Side pockets for the valves are avoided and the valves are inserted in their guides from below through the cylinder. The piston has a large diameter and relatively small stroke. Due to the large cylinder diameter the valves, and particularly the inlet valve, can be made comparatively large. Since the cylinder and the cylinder head are produced in one piece and the valves are controlled from above, the cylinder housing can be effectively cooled over its whole height or length by the cooling water, whilst the cooling water can also be conducted into the vicinity of the bearings of the crankshaft.—*November* 19, 1952.



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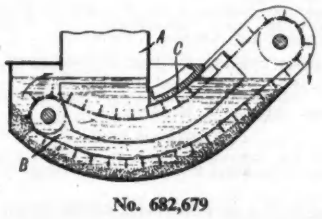
FURNACES

682,679. September 21, 1949.—EMPTYING FINE ASH AND SLAG FROM FURNACES, Josef Martin, 14, Montsalvatstrasse, Munich, 23, Germany.

As indicated in the upper drawing, below the furnace is a shaft *A* opening into a slag chamber *B*, with a curved bottom and filled with water. A conveyor, shown chain dotted, runs into the slag chamber. The conveyor is formed of two chains, interconnected by means of angle irons. The lower lap of the conveyor sags freely, and, when the accumulation of slag on the bottom of the chamber is sufficient, skims or scoops off the top of this accumulation, moving it towards the end of the chamber. When a sufficient quantity of slag has built up a certain amount is taken up by each successive angle iron and is carried away to be deposited outside the chamber.



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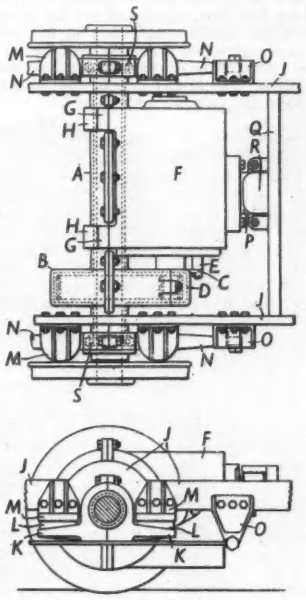
Thus the amount of slag on the bottom is controlled. The top lap of the conveyor is guided to move in a predetermined path by guide plates *C*. In order to avoid any tendency for the sag of the conveyor to be taken up or in order to control the sag, the return shaft and the driving shaft may be directly coupled together by a means through which one shaft may rotate, by a variable amount, before the other shaft commences to turn.—*November* 12, 1952.

RAIL AND ROAD TRANSPORT

682,772. May 30, 1949.—THE MOTOR SUSPENSION OF ELECTRIC RAILWAY AND TRAMWAY VEHICLES, Alfred Walter Maley, "Summerdown," Bridgnorth Road, Wombourn; and Edmund Mackenzie Taunton, "Mikra," Carlton Road, Malvern.

In railway and tramway vehicles which have their wheels outside the truck frame, a sleeve to support the motor is made integral with the axleboxes and is supported by bearings serving as the axlebox bearings. The sleeve *A* extends the whole length from the inner face of one wheel to the inner face of the other, save for running clearance. It may be built in two halves divided on a vertical plane. Near one end the sleeve is enlarged to form the gear casing *B*. A lug *C* upon the casing cap *D* enclosing the pinion is bolted to a



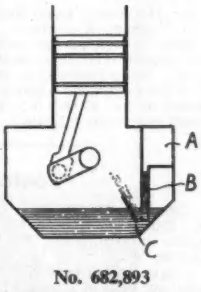
No. 682,772

boss *E* on the motor carcase *F*. Upon the motor carcase are lugs *G*, which half surround the sleeve, and to these are bolted clamping caps *H*, which complete the encirclement of the sleeve *A* and make the motor *F* fast to it. The side frames *J* are arched over the sleeve ends which form the axleboxes. Below the axle each axlebox has wings or brackets *K* extending fore and aft, and these are cupped to receive rubber blocks *L* which serve as the truck springs, and also permit the slight rocking of the sleeve which accompanies relative movement of truck and axle. On these blocks rest cupped brackets *M*, secured to the side frame. In the case of hornless trucks a resilient anchor link *N* is fastened by set screws to the two halves of the axlebox and pivotally attached to brackets *O*. The support of the motor *F* is completed by a bracket *P* cupped above and below, extending from the carcase towards a cross member *Q* of the frame from which cupped lugs *R* project above and below the bracket; between the bracket and lugs rubber springs are interposed. In the outer end of each axlebox is a coned or cylindrical roller bearing *S*, and upon these the whole of the sleeve and its load are borne.—*November* 19, 1952.

MISCELLANEOUS

682,893. August 14, 1950.—LUBRICATION OF RECIPROCATING ENGINES, N. V. Philips' Gloeilampenfabrieken, Emmasingel, 29, Eindhoven, Holland.

In the engine shown the connecting-rod to the reciprocating piston brings about periodic variations in pressure in the crank case, which contains an amount of lubricant. Within the crankcase is an auxiliary space *A* which communicates by way of a tube *B* with the crankcase, and an aperture is provided in the tube below the level of the lubricant. During periods of highest pressure in the crankcase, when the piston occupies its lowest position, an amount of lubricant is caused to flow into the auxiliary space due to the high pressure in the crankcase. The air in the auxiliary space is thus also subjected to a pressure which substantially equals the maximum pressure in the crankcase. When the piston moves upwards so that the pressure in the crankcase decreases, lubricant is forced from the tube into the crankcase by the action of the comparatively high pressure of the air in the auxiliary space. This lubricant sprays against a partition *C* and is atomised so that a mist of oil is produced.—*November* 19, 1952.



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British Standard sInstitution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 24, Victoria Street, London, S.W.1.

STIRRUP PUMPS, PART I : PISTON TYPE

No. 1901, Part I : 1952. This standard replaces B.S. A.R.P. 33, which was published during the war. In it there has been eliminated all the unnecessary constructional details which were in the old document. It is concerned primarily with the workmanship and performance of the stirrup pump, specifying merely those dimensions which are necessary to ensure adequate performance. Price 2s.

COMMERCIAL PLATINUM RESISTANCE THERMOMETER ELEMENTS

No. 1904 : 1952. The recently published British Standard for "Commercial Platinum Resistance Thermometer Elements" forms one of a series being prepared in relation to temperature measurement. It specifies requirements for temperature-sensitive resistance elements made of platinum foil, strip or wire, usually contained in a sheath forming a thermometer bulb, and used with suitable electrical indicators, recorders and/or controllers for a variety of industrial purposes. The standard includes tests for stability and behaviour under vibration. Price 2s. 6d.

SPARKING PLUGS

No. 45 : 1952. This revision aims at providing a common standard for both aircraft and general-purpose sparking plugs, and is intended to supersede both B.S. 45 : 1928, "Sparking Plugs for Automobile Engines," and British Standard E.9, "Sparking Plugs for Aircraft Engines." The provisions of the standard are mainly dimensional, and relate to such matters of general design as standard reaches and terminals, body hexagon, counterbore of tapped hole, &c., and to the limits and tolerances for the screw thread of the plug and the tapped hole. In assigning tolerances to the threads, and in the standardisation of certain general features of design, full consideration has been given to the desirability of achieving the closest possible measure of interchangeability between British sparking plugs and plugs made to American aircraft and automobile standards. Standardisation has been confined to the 14mm sparking plug since it is considered that other sizes are now obsolescent. Price 4s.

Launches and Trial Trips

ATLANTIC LORD, oil tanker; built by the Furness Shipbuilding Company, Ltd., for S. G. Livanos; length between perpendiculars 525ft, breadth moulded 71ft, depth moulded 39ft 3in, deadweight 18,200 tons on 30ft 6in summer draught, designed speed 15·5 knots; two 75kW steam-driven generators, one 35kW diesel generator; Wallsend-Doxford single-acting, two-stroke oil engine, six cylinders, 725mm diameter by 2250mm combined stroke, 7600 b.h.p. at 117 r.p.m., heavy oil fuel, two Scotch boilers. Launch, December 15th.

CALTEX BAHRAIN, oil tanker; built by R. and W. Hawthorn, Leslie and Co., Ltd., for Overseas Tankships (U.K.), Ltd.: length overall 544ft 4in, breadth moulded 70ft, depth 39ft 9in, deadweight 17,450 tons; one set of double reduction geared turbines of 8200 s.h.p., taking steam at 450 lb per square inch and 750 deg. Fah. from two Yarrow boilers, two 400kW geared turbo-generators, one 50kW diesel generator. Launch, December 16th.

RAMSAY, cargo liner; built by Smith's Dock Company, Ltd., for the Bolton Steam Shipping Company, Ltd.; length between perpendiculars 426ft, breadth moulded 59ft, depth moulded to upper deck 38ft 3in, deadweight 10,260 tons on 26ft 2½in draught, five cargo holds, trial speed 13½ knots; one triple-expansion engine having cylinders 24½in, 40in and 68in diameter by 45in stroke, Bauer-Wach exhaust turbine, 3000 s.h.p. at 85 r.p.m., steam supplied at 220 lb per square inch and 580 deg. Fah. by three single-ended multitubular boilers, two 33kW steam-driven generators. Trial, December 16th.

LA HACIENDA, cargo liner; built by Swan, Hunter and Wigham Richardson, Ltd., for Buries Markes; length between perpendiculars 435ft, breadth moulded 60ft, depth moulded to shelter deck 39ft, gross tonnage 6000; Swan Hunter-Doxford oil engine to burn heavy fuel, four cylinders 670mm diameter by 2320mm combined stroke, 4400 b.h.p. at 115 r.p.m., three 175kW diesel generators. Launch, December 17th.

Contracts

THE ENGLISH ELECTRIC COMPANY, Ltd., has received an order to manufacture high-voltage transformers worth approximately 700,000 dollars for the City of Seattle, Washington, U.S.A. Each of the transformers will have a capacity of 125MVA, three phase, 60 c/s, with a voltage ratio of 220/26kV, and will be built at the company's Stafford works.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on or before the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Thurs., Jan. 1st.—S. LONDON BRANCH: Cafe Royal, North End, Croydon, "Repair and Renovation of Electrical Apparatus," 8 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Mon., Jan. 5th.—LONDON SECTION: School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, W.C.1, "The Modern Single-Layer Selenium Photocell," G. A. Veszi, 6.30 p.m.

Thurs., Jan. 8th.—SCOTTISH SECTION: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, Film Evening, 7 p.m.

CLEVELAND INSTITUTION OF ENGINEERS

Mon., Jan. 5th.—Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough, "Operation of Blast-Furnaces at Clyde Ironworks at High Top Pressure," R. P. Towndrow, 6.30 p.m.

COMMUNICATION TRAINING CENTRE

Mon., Jan. 5th.—University College, Gower Street, London, W.C.1, day conference dealing with "Language in Presentation," "Logic in Presentation," and "The Psychology of Presentation," Reginald O. Kapp, B. C. Brookes and A. C. Leyton, 9.30 a.m.-4.30 p.m.

ENGINEERS' GUILD

Tuesday, Jan. 6th.—W. MIDLANDS BRANCH: Imperial Hotel, Temple Street, Birmingham, "Presentation of Technical Information," R. O. Kapp, 6.30 p.m.

HULL CHEMICAL AND ENGINEERING SOCIETY

Thurs., Jan. 8th.—Church Institute, Albion Street, Hull, "Science and Domestic Heating," R. A. Mott, 7.30 p.m.

Tues., Jan. 13th.—Church Institute, Albion Street, Hull, Presidential Address, "Oil Additives," G. E. Gray, 7.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

Thurs., Jan. 1st.—EXETER GROUP: Providence Hall, Northernhay Street, Exeter, Discussion on Home Lighting, 7 p.m.

Fri., Jan. 2nd.—BATH AND BRISTOL CENTRE: S.W. Electricity Board Lecture Theatre, Colston Avenue, Bristol, Discussion on Home Lighting, 5.30 p.m.——BIRMINGHAM CENTRE: Main Hall, College of Technology, Suffolk Street, Birmingham, Exhibition of New Lighting Equipment, 6 p.m.

Wed., Jan. 7th.—LONDON CENTRE: Visit to Croydon "B" Power Station.——EDINBURGH CENTRE: Welfare Club Hall, Lighting and Cleansing Department, 357, High Street, Edinburgh, "Colour as a Framework to Industry," Mrs. D. M. Buckland," 7 p.m.——NEWCASTLE CENTRE: Minor Durrant Hall, Oxford Street, Newcastle upon Tyne, "Museum and Art Gallery Lighting," W. E. Rawson-Bottom, 6.15 p.m.

Thurs., Jan. 8th.—GLASGOW CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "Colour as a Framework to Industry," Mrs. D. M. Buckland, 6.30 p.m.——MANCHESTER CENTRE: Demonstration Theatre, N.W. Electricity Board, Town Hall Extension, Manchester, "Lighting in the Food Industry," R. L. C. Tate, 6 p.m.——NOTTINGHAM CENTRE: Demonstration Theatre, E. Midlands Electricity Board, Smithy Row, Nottingham, Student Members' Viewpoints, J. Eddyshaw, W. Mosedale, N. S. Rutherford and J. R. Wakefield, 6 p.m.

INCORPORATED PLANT ENGINEERS

Thurs., Jan. 1st.—PETERBOROUGH BRANCH: Eastern Gas Board's Demonstration Theatre, Church Street, Peterborough, Open Discussion on Automobiles, 7.30 p.m.

Fri., Jan. 2nd.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham, "Metal Spraying for Protection," W. E. Ballard; "The Reclamation of Worn Parts by Metal Spraying," R. Wallwork, 7.30 p.m.

Tues., Jan. 6th.—LONDON BRANCH: Royal Society of Arts, John Adam Street, Adelphi, Strand, W.C.2, Discussion on the National Fuel Policy, 7 p.m.—S. WALES BRANCH: S. Wales Institute of Engineers, Park Place, Cardiff, "A Plant Engineer Tours America," G. E. Halter, 7.15 p.m.

Wed., Jan. 7th.—SOUTHAMPTON BRANCH: Polygon Hotel, Southampton, "Metallising in Relation to Plant Maintenance," J. Porter, 7.30 p.m.

Thurs., Jan. 8th.—NEWCASTLE UPON TYNE BRANCH: Roadway House, Oxford Street, Newcastle upon Tyne, "Preventive Maintenance," T. C. Robinson, 7.30 p.m.

INSTITUTE OF ECONOMIC ENGINEERING

Fri., Jan. 9th.—Cowdray Hall, Henrietta Place, Cavendish Square, London, W.1, "Work Study as a Means of Improving Industrial Efficiency," R. M. Currie, 7 p.m.

INSTITUTE OF FUEL

Tues., Jan. 6th.—SCOTTISH SECTION: Royal Technical College, Glasgow, "The Ridley Report and After," Gerald Nabarro, 7 p.m.

INSTITUTE OF INDUSTRIAL SUPERVISORS

Thurs., Jan. 8th.—LONDON CENTRAL SECTION: Polytechnic, Regent Street, W.1, Annual General Meeting and Industrial Film Show, 7.30 p.m.

INSTITUTE OF MARINE ENGINEERS

Tues., Jan. 13th.—85, Minories, London, E.C.3, "Some Operating Experiences with Two-Stroke Cycle Engines on Boiler Oil and the Development of Fuel Injection Equipment," A. G. Arnold, 5.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Tues., Jan. 6th.—EASTERN CENTRE: Mess Room, Eastern Counties Omnibus Company, Norwich, "Electrical Equipment as Applied to the Modern Heavy Commercial Vehicle," W. A. Bevis, 7 p.m.

Wed., Jan. 7th.—E. MIDLAND CENTRE: Mechanics Institute, Nottingham, "The Application of Synthetic Resin Adhesives in the Road Transport Industry," T. Maxwell-Hudson, 7.30 p.m.

Thurs., Jan. 8th.—WESTERN CENTRE: Grand Hotel, Bristol, "Electrical Equipment as Applied to the Modern Heavy Commercial Vehicle," W. A. Bevis, 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Dec. 30th.—AIRPORT MEETING: Great George Street, Westminster, London, S.W.1, "The Reconciliation of Civil Engineering Problems with International Standards in the Siting and Planning of Airports," A. S. MacLaren, 5.30 p.m.

Tues., Jan. 6th.—MARITIME MEETING: Great George Street, Westminster, London, S.W.1, "The Reconstruction of Greenwell's No. 1 Dry Dock and Ancillary Works at Sunderland," Harry Ridehalgh, 5.30 p.m.

Thurs., Jan. 8th.—MIDLANDS ASSOCIATION: James Watt Memorial Institute, Great Charles Street, Birmingham, "Prestressed Concrete in Civil Engineering Works," A. J. Harris, 6 p.m.—N.W. ASSOCIATION: Engineers' Club, Albert Square, Manchester, "The Management of a Railway District Engineer's Office and Some Reference to Permanent Way Design," A. L. Owen, 6.30 p.m.

Tues., Jan. 13th.—PUBLIC HEALTH MEETING: Great George Street, Westminster, London, S.W.1, "The Storage, Collection and Disposal of Refuse," J. C. Dawes, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., Jan. 5th.—S. MIDLAND CENTRE: James Watt Memorial Institute, Great Charles Street, Birmingham, "Post-Graduate Activities in Electrical Engineering," W. J. Gibbs, D. Edmundson, R. G. A. Dimmick, and G. S. C. Lucas, 6 p.m.

Tues., Jan. 6th.—MEASUREMENTS AND RADIO SECTIONS: Savoy Place, London, W.C.2, "An Improved Scanning Electron Microscope for Opaque Specimens," D. McMullan, 5.30 p.m.——N. MIDLAND CENTRE: British Electricity Authority, 1, Whitehall Road, Leeds, 1, "Electronic Telephone Exchanges," T. K. Flowers, 6.30 p.m.

Wed., Jan. 7th.—TEES-SIDE SUB-CENTRE: Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough, "Domestic Electrical Installations—Some Safety Aspects," H. W. Swann, 6.30 p.m.——SOUTHERN CENTRE: Technical College, Brighton, "275kV Developments on the British Grid System," D. P. Sayers, J. S. Forrest and F. J. Lane, 6.30 p.m.——N. SCOTLAND SUB-CENTRE: Caledonian Hotel, Aberdeen, "The Economics of Low-Voltage Supplies to New Housing Estates," F. G. Copland, 7.30 p.m.

Thurs., Jan. 8th.—ORDINARY MEETING: Savoy Place, London, W.C.2, "Nuclear Reactors and Applications," Sir John Cockcroft, 4.30 p.m., Symposium of Papers on "Nuclear Reactor Instrumentation," 6 p.m.—N. SCOTLAND SUB-CENTRE: Royal Hotel, Dundee, "The Economics of Low-Voltage Supplies to New Housing Estates," F. G. Copland, 7 p.m.

INSTITUTION OF ENGINEERING INSPECTION

Thurs., Jan. 1st.—LONDON BRANCH: Royal Society of Arts, John Adam Street, Adelphi, W.C.2, "Standardisation and Inspection," E. G. Brisch.

Tues., Jan. 6th.—COVENTRY BRANCH: Technical College, Coventry, "Developments in the Manufacture and Uses of Glass," R. E. Bastick, 7.30 p.m.——S.W. BRANCH: Grand Hotel, Broad Street, Bristol, "Arc Welding," G. G. Marshall, with Films, 7.30 p.m.

Wed., Jan. 7th.—BIRMINGHAM BRANCH: Chamber of Commerce, New Street, Birmingham, Film Evening, "Output and the Individual" and "The Factory and its Equipment," 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Fri., Jan. 2nd.—GENERAL MEETING: Storey's Gate, St. James's Park, London, S.W.1, "Principles and Practice Governing Interchangeability and the Specification of Manufacturing Limits of Size as Influenced by Statistical Considerations," G. C. Adams, 5.30 p.m.

Tues., Jan. 6th.—S.W. BRANCH: S. Wales Institute of Engineers, Park Place, Cardiff, "Contemporary Methods of Watch Production," R. A. Fell and P. Indermuhle, 6 p.m.——LONDON GRADUATES' SECTION: Storey's Gate, St. James's Park, S.W.1, "Industrial Power Transmission Clutches and Couplings," K. J. Freeman, 6.30 p.m.

Fri., Jan. 9th.—GENERAL MEETING IN CONJUNCTION WITH HYDRAULICS GROUP: Storey's Gate, St. James's Square, London, S.W.1, "Control Valves for Direct-Hydraulic Presses," F. H. Towler and J. M. Towler, 5.30 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Thursday, Jan. 8th.—LONDON SECTION: Old Ship Hotel Assembly Rooms, Brighton, Film Evening, "Pattern for Progress," 7 p.m.

INSTITUTION OF SANITARY ENGINEERS

Wed., Jan. 7th.—Visit to the Laboratories and Demonstration Plant of the Cement and Concrete Association, Wexham, Near Slough, 2.30 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Fri., Jan. 2nd.—WESTERN COUNTIES BRANCH: Geology Lecture Theatre, The University, Bristol, "Unusual Design for a Large Constructional Shop," F. R. Bullen, 6 p.m.

Thurs., Jan. 8th.—JOINT MEETING WITH THE REINFORCED CONCRETE ASSOCIATION: 11 Upper Belgrave Street, London, S.W.1, "The Construction of Eight Prestressed Concrete Tanks," A. R. Mais, 5.55 p.m.

JUNIOR INSTITUTION OF ENGINEERS

Fri., Jan. 2nd.—Townsend House, Greycoat Place, London, S.W.1, Film Evening, "Packaged Power," introduced by H. M. Louch, 7 p.m.

Wed., Jan. 7th.—MIDLAND SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, Chairman's Address, "Some Aspects of Modern Material Handling," O. B. Orwin, 7 p.m.

Fri., Jan. 9th.—ORDINARY MEETING: Townsend House, Greycoat Place, London, W.1, "Automatic Feed Pressworking," C. H. Crawford, 7 p.m.

LIVERPOOL METALLURGICAL SOCIETY

Thurs., Jan. 8th.—Liverpool Engineering Society, The Temple, Dale Street, Liverpool, Open Discussion, 6.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Fri., Jan. 9th.—Mining Institute, Newcastle upon Tyne, "Marine Steam Turbines," J. Brown, 6.15 p.m.

ROYAL INSTITUTION OF CHARTERED SURVEYORS

Mon., Jan. 5th.—ORDINARY GENERAL MEETING: 12, Great George Street, Westminster, London, S.W.1, "The Schemes of the North of Scotland Hydro-Electric Board," W. M. Robertson and T. Lawrie, 5.30 p.m.

END OF VOL. 194

The Engineer

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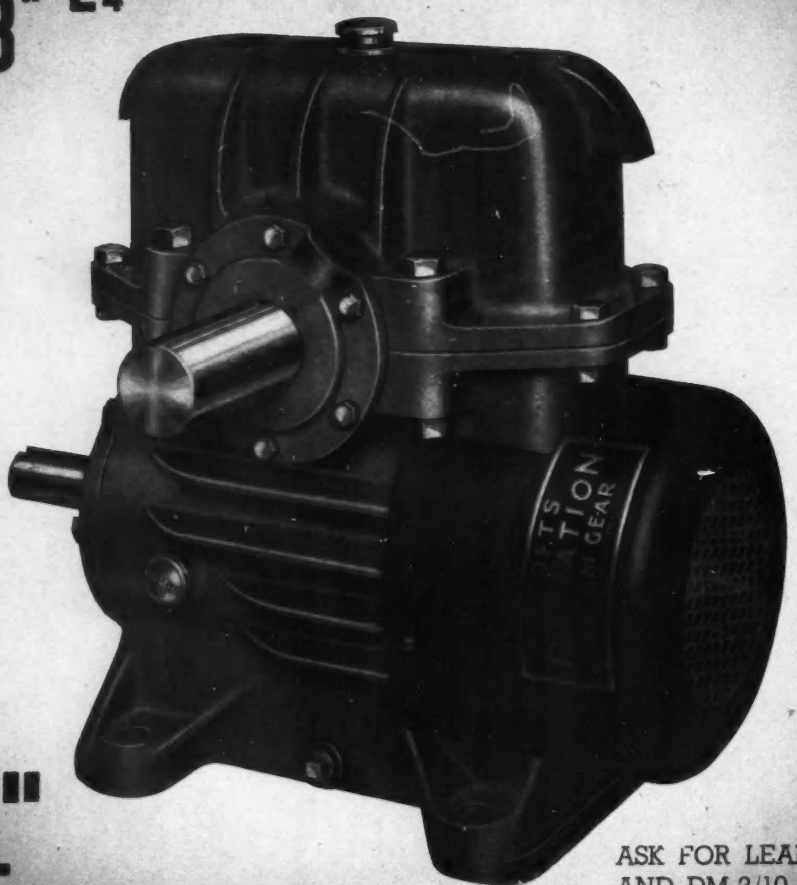

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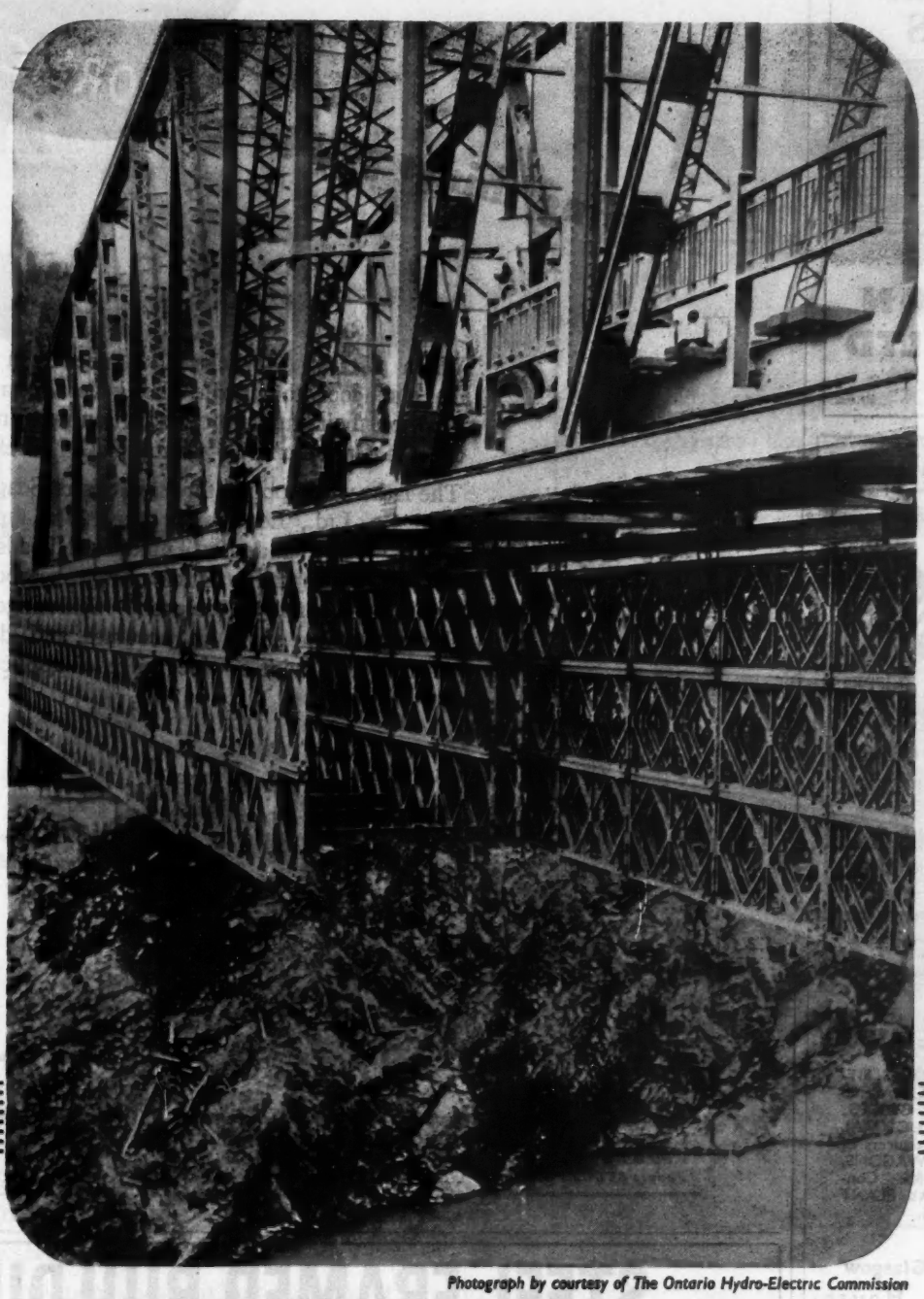

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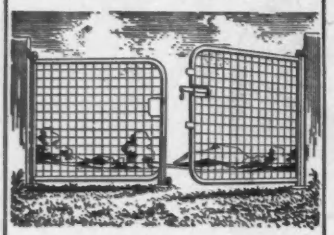

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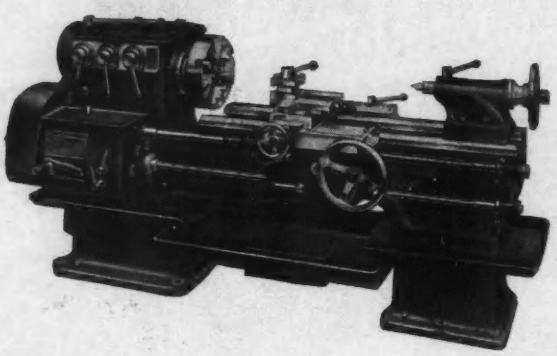

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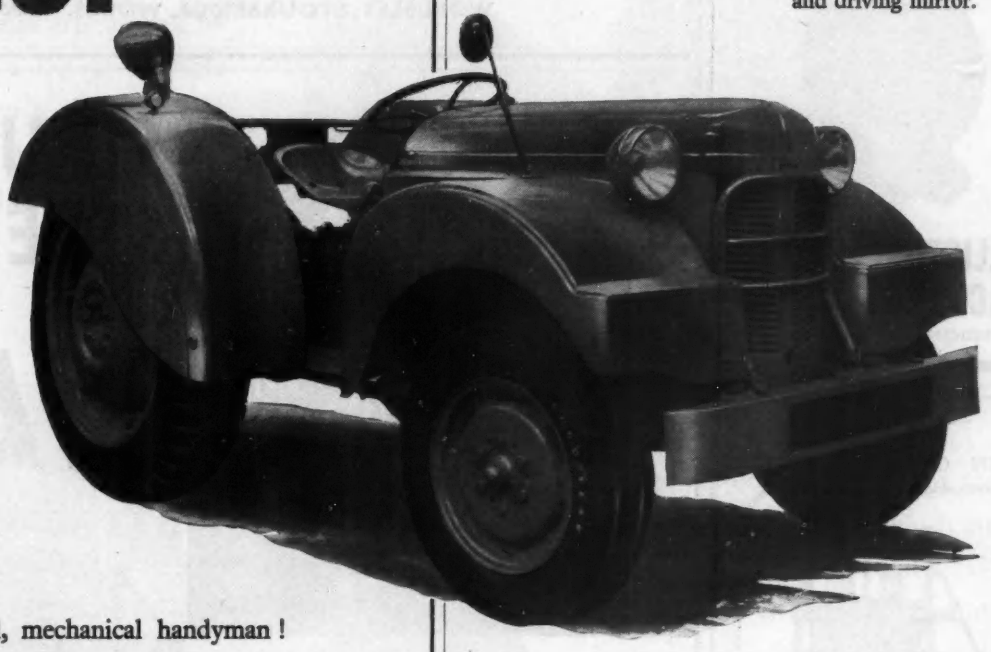

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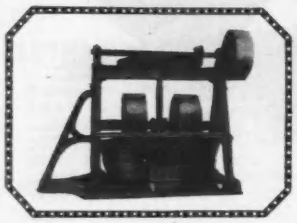

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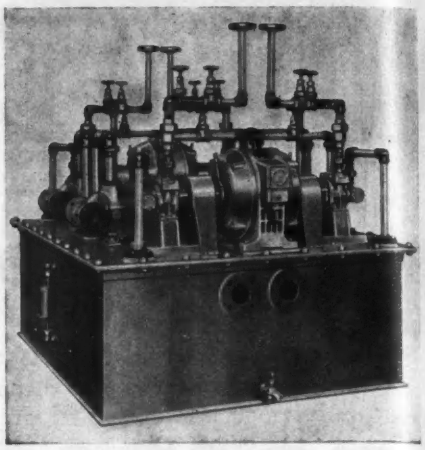

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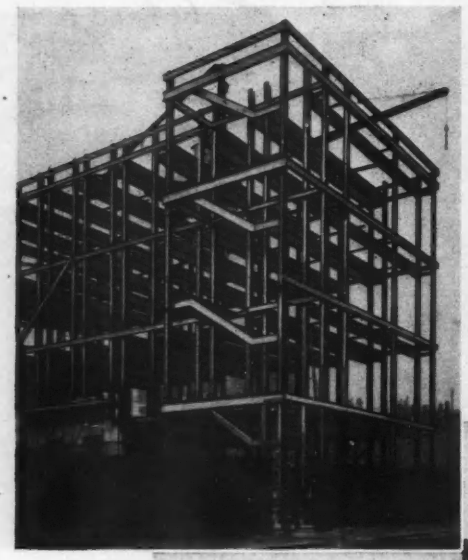

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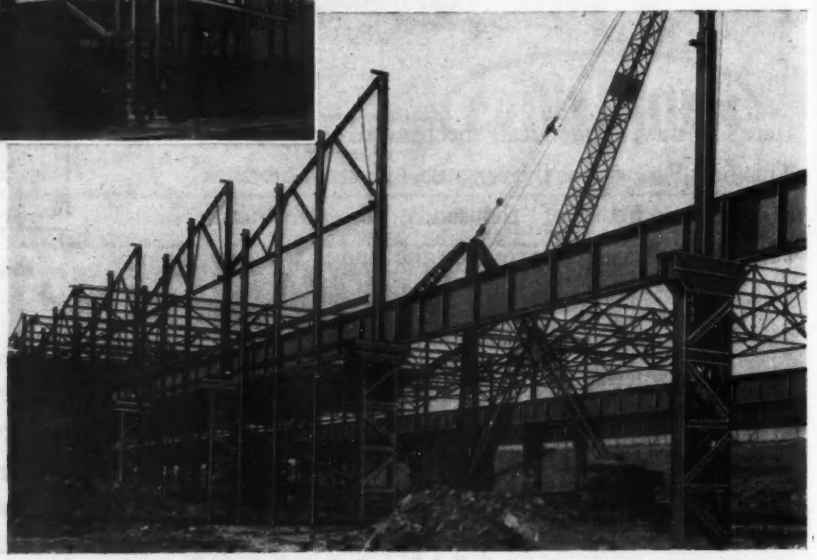

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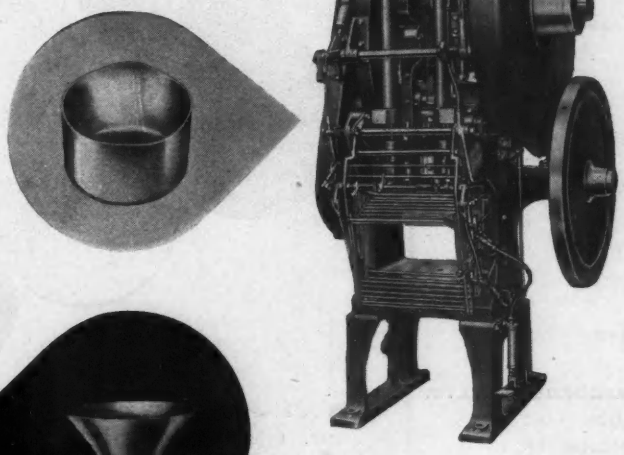

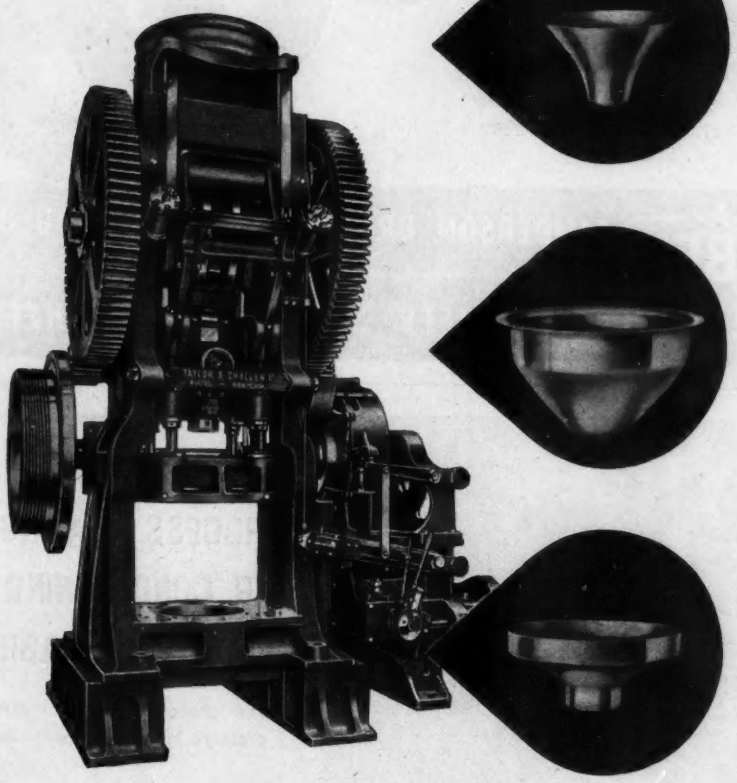

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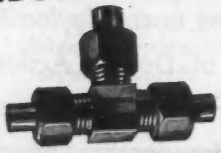

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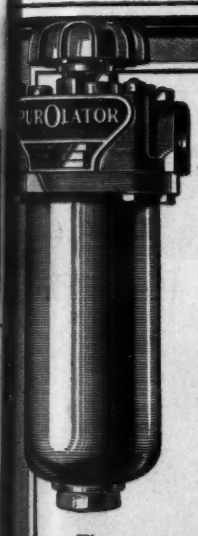

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metal-element filters
(FULLY PATENTED)

For precision filtration

Wound from specially-formed wire by a patented process, the Purolator filter has filter spaces which are precision-made.

The completed element is permanent and has a smooth cylindrical exterior which is easily cleaned by the turn of a handle, without in any way disturbing the filter or its pipe-connections.

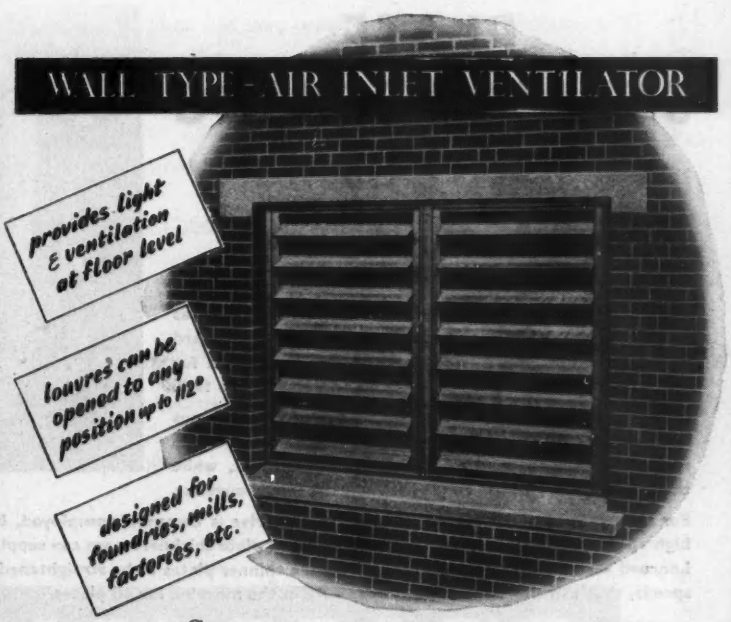
The construction is highly efficient, non-choking, and gives perfect edge filtration. The standard elements are made in brass, but other metals such as Monel metal or stainless steel can be used in quantity production, for fuel oil, lubricating oil or other purposes.

Compact: light: permanent: 'cleanable'.

AUTOMOTIVE PRODUCTS COMPANY LTD.
LEAMINGTON SPA

Regd. Trade Mark
PUROLATOR
METAL ELEMENT FILTERS

HILLS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provides light & ventilation at floor level
louvres can be opened to any position up to 112°
designed for foundries, mills, factories, etc.

Scientifically designed as a standard unit for easy installation into an opening 8ft. wide × 6ft. high, this sturdy welded all-steel Ventilator will give efficient trouble-free service. The two banks of eight centrally pivoted louvre vanes, completely weathertight when fully closed, are operated from a single handle to clear smoke, fumes and heat, and permit entry of fresh air and light. Rustproofed by hot dip galvanising. Descriptive literature free on request.

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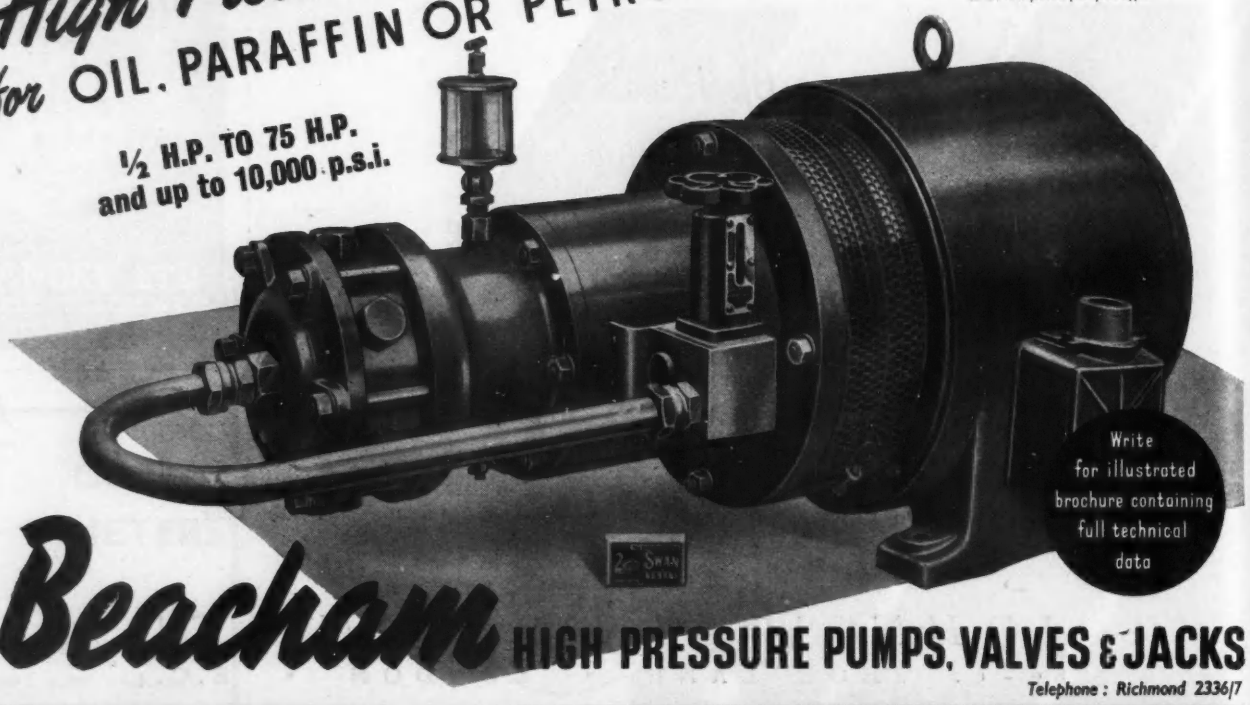
for OIL. PARAFFIN OR PETROL . . .

½ H.P. TO 75 H.P.
and up to 10,000 p.s.i.

Illustration shows pump type SWD 19.25 g.p.m. up to 2,400 p.s.i. for paraffin.



Write for illustrated brochure containing full technical data

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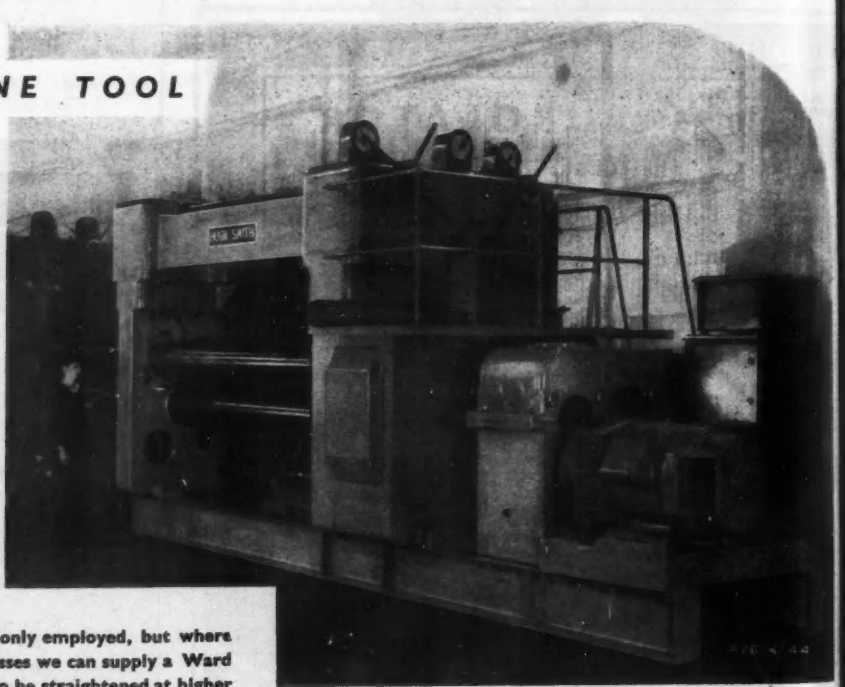
Manufactured under licence by OSWALDS & RIDGWAY LTD. STATION AVENUE · KEW GARDENS · SURREY

A HUGH SMITH MACHINE TOOL

PLATE STRAIGHTENING ROLLS

for light and heavy duty



Hugh Smith plate straightening rolls are of the most modern design and construction. The seven roller type, as illustrated on right, is our standard machine for shipyard and general use, and a wide range of sizes is available for plates from ¼ in. thick to 2 in. thick and widths up to 10 ft.

The larger sizes of machine have motor driven simultaneous vertical adjustment of the top rollers, the two outside rollers having independent handwheel adjustment, while the smallest machine has handwheel adjustment throughout.

For normal work the direct single speed motor drive is commonly employed, but where high speed production is required on a range of plate thicknesses we can supply a Ward Leonard variable speed drive which allows the thinner plates to be straightened at higher speeds, thus utilising the full power capacity of the machine for all plates.

PLATE BENDING ROLLS · PLATE STRAIGHTENING ROLLS · BULKHEAD FLANGING PRESSES · PLATE EDGE PLANERS AND PLANO-SHEARS
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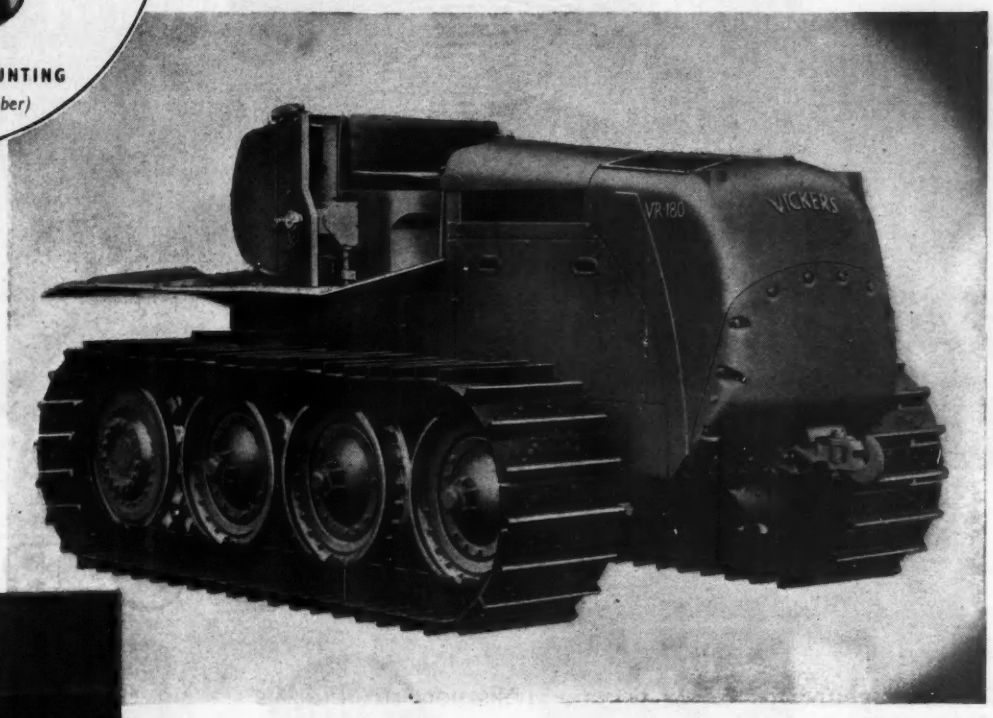
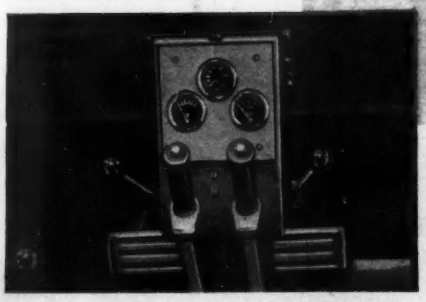
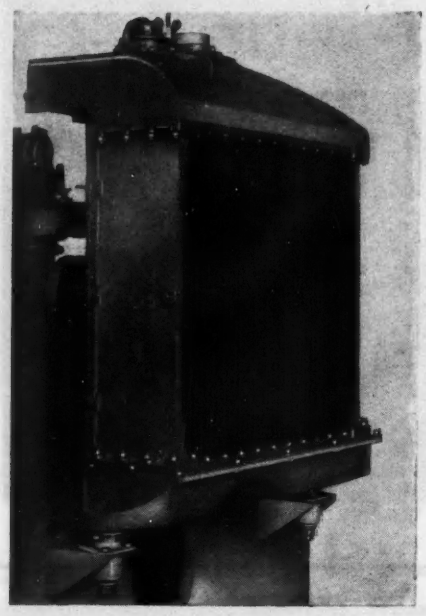


Britain's answer to the demand for faster and more powerful traction — The Vickers VR.180 distributed by Jack Olding & Co. Ltd.



Instrument Panel and Radiator on the Vickers VR.180 are insulated from vibration by Silentbloc Anti-Vibration Mountings.



● **Longer life for equipment and pleasanter working conditions result from the reduction of vibration. Whatever the load, whatever the installation, there are Silentbloc mountings to take care of the vibration. But don't wait to apply the cure after the machine has been built or installed. Provision for flexible mountings in the design stage saves time and expense.**

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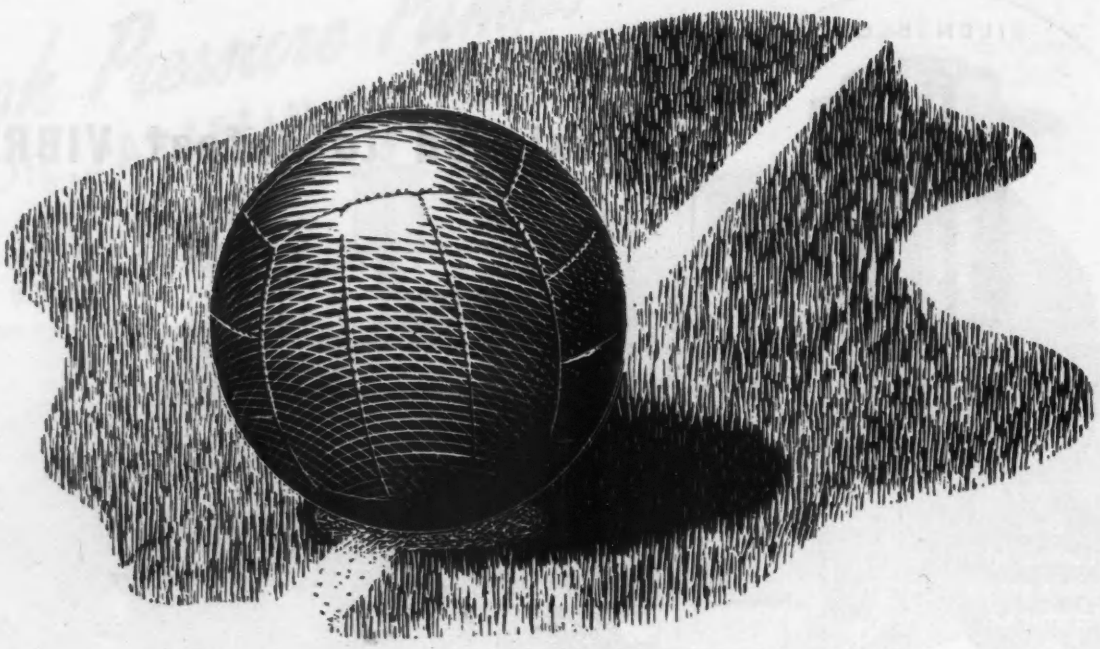

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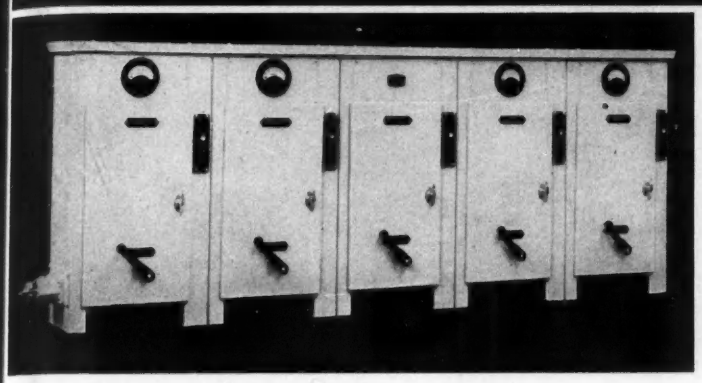
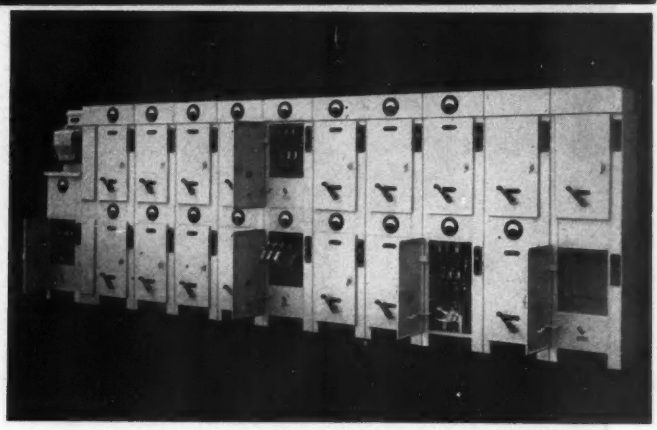
AIR-BREAK
ELECTRIC MOTOR CONTROL GEAR
FOR INDUSTRIAL APPLICATIONS
(up to 650 volts A.C.)

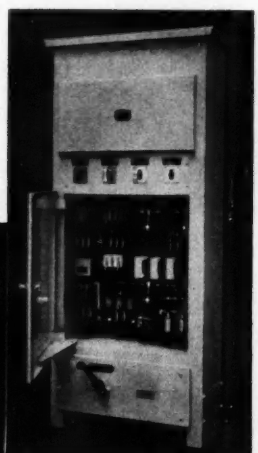


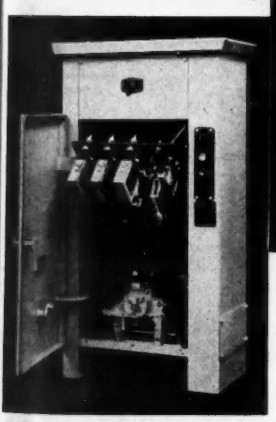
Single Tier motor control switchboard with individual isolation, ammeters and arranged for local push-button control.



22-Unit Double Tier motor control switchboard comprising 300 amp. incoming switch and fuse unit, and contactors catering for various duties up to 100 h.p.

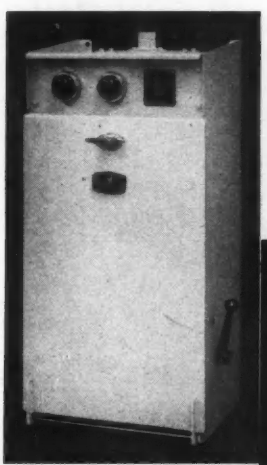
Pillar-type motor starter incorporating three direct-on starters and one stator rotor starter arranged for automatic sequence control and fitted with isolating switch.



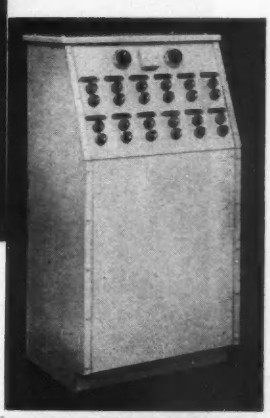


Type DO.75 Single Pillar motor starter showing accessibility of interior (isolator shield removed). Fitted with local push-buttons and "Local-Remote" rotary selector switch.

BELMOS



Type M.150 Contactor Unit suitable for direct mounting on Capacitor tank for power factor correction.



Remote Control Desk for group motor starting with indicator lamps.

A variety of arrangements is available to suit individual requirements.

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MORGAN
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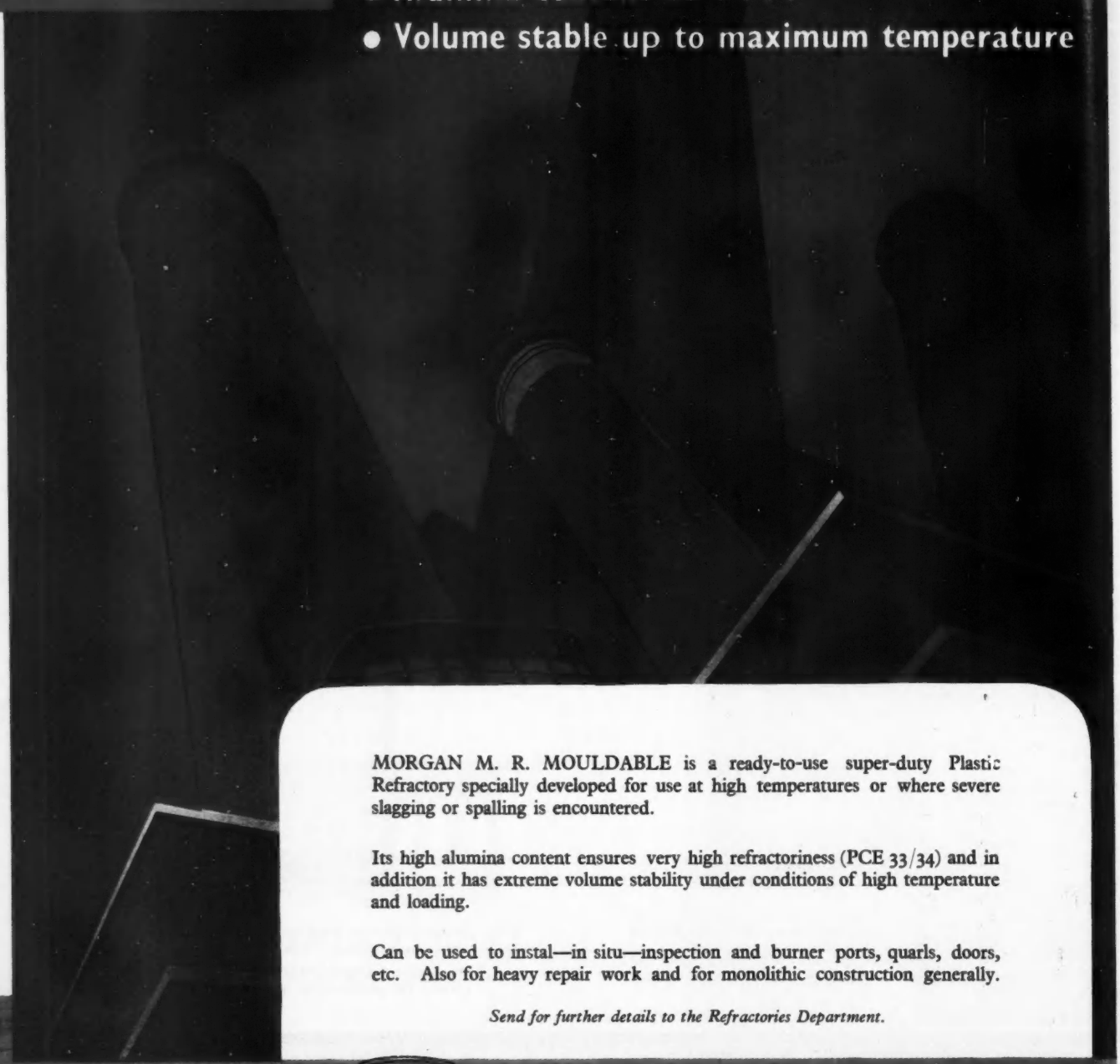
Super-Duty Refractory.

- Maximum operating temperature 1650° C
- Resists thermal spalling
- Alumina content 60 . . .
- Volume stable up to maximum temperature



MORGAN M. R. MOULDABLE is a ready-to-use super-duty Plastic Refractory specially developed for use at high temperatures or where severe slagging or spalling is encountered.

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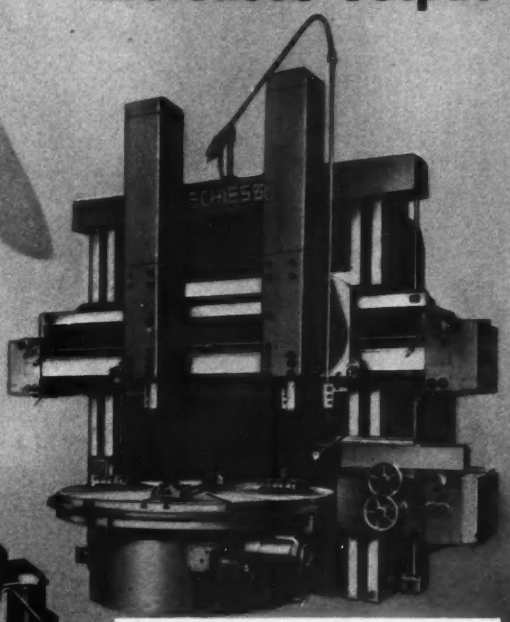
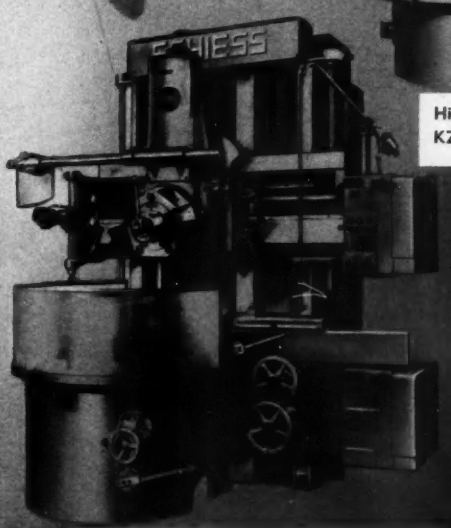
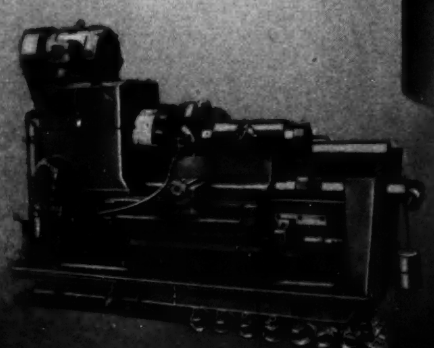


High Speed Double Column Boring Mill, Model KZ 250, Maximum Turning Diameter 8′ 3″



High Speed Single Column Boring Mill, Model KE 125, Maximum Turning Diameter 4′ 1″



Semi-Automatic Lathe, Model HA 420, with special set-up for machining differential gear cases

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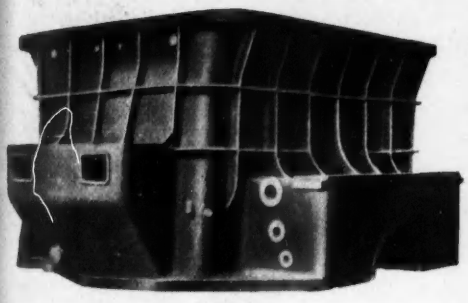
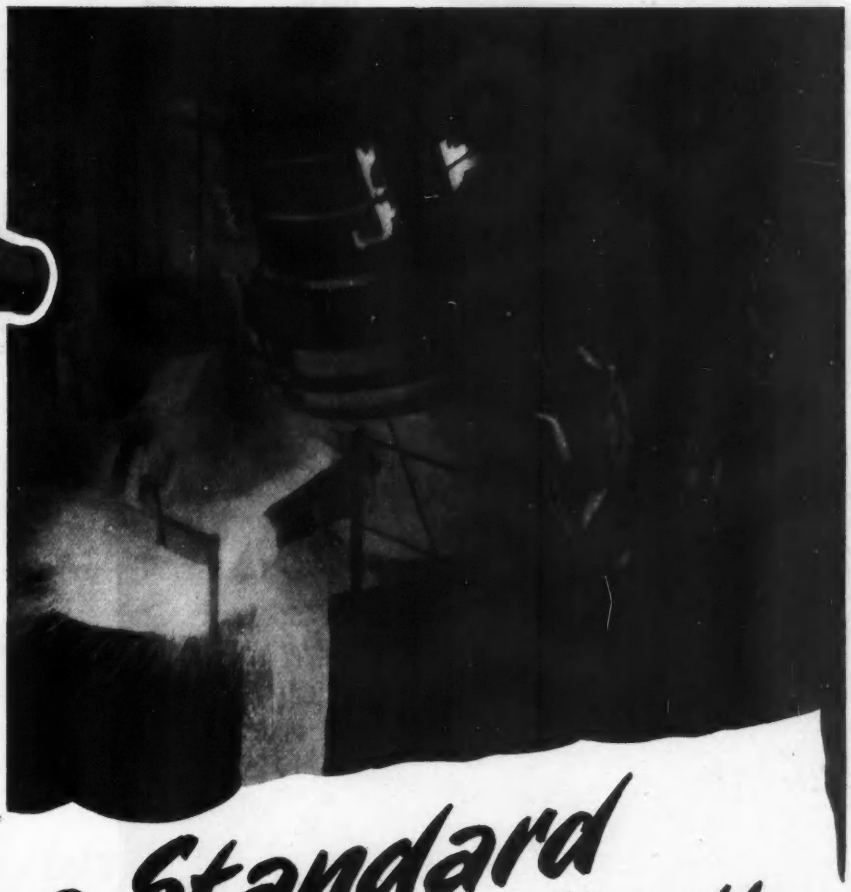


35 Ton Gear Case for Royal Navy



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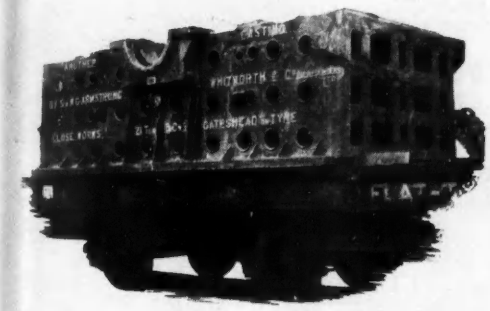

21 Ton Gear Case

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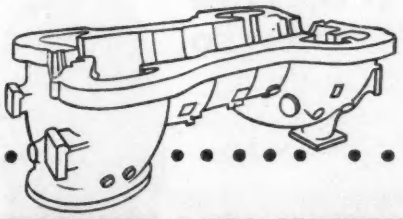
No matter whether your requirements are the largest or the smallest, and whatever the problems involved, you can call in Armstrong Whitworth with every confidence.



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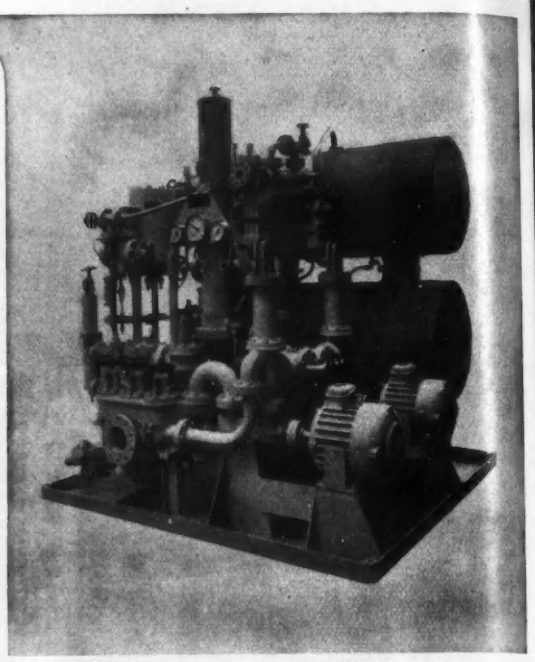

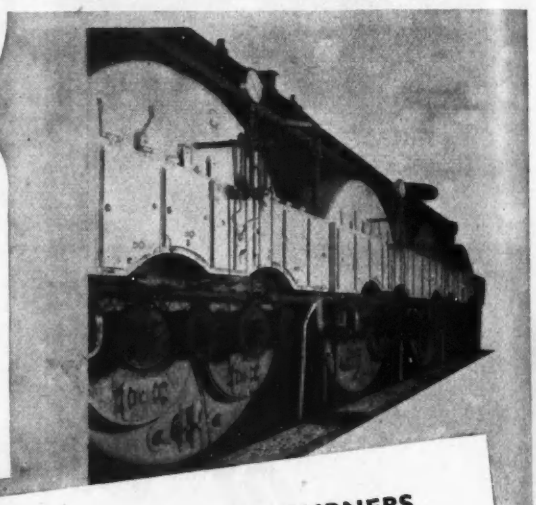

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"Wallsend" Burners are available for home produced fuels including Creosote-Pitch mixture and for the ignition of pulverised coal.

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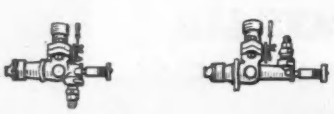
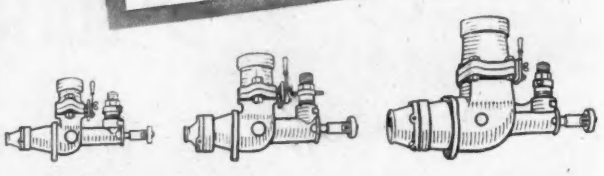
- Glass Tanks.
- Lehrs and Glory Holes.
- Crucible Furnaces of all types, etc.



BURNERS OF ALL



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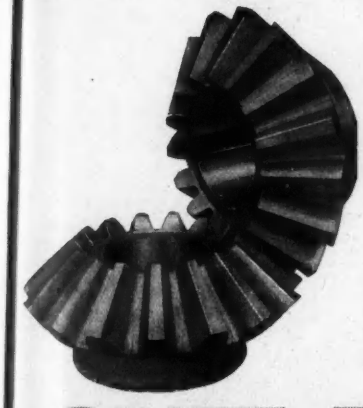

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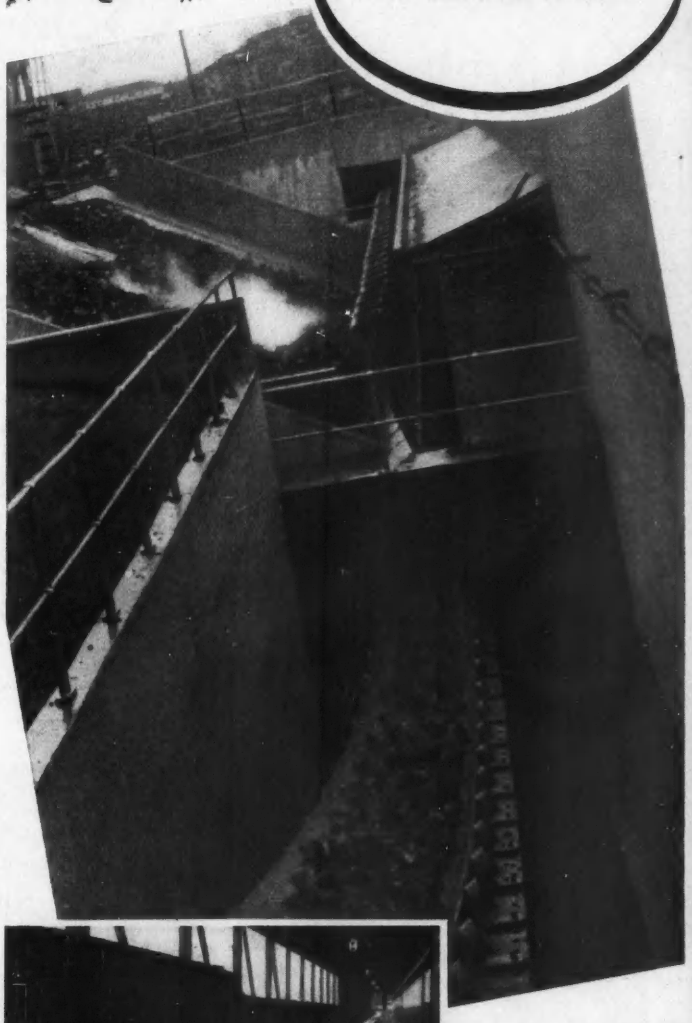

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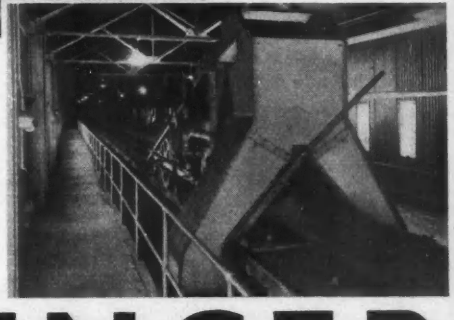

Top. Spencer troughed belt Conveyor handling hot coke.
Above. Belt Conveyor forming part of a large installation supplied to the South Eastern Gas Board.
Right. 36" Coal Conveyor fitted with automatic tripper having a capacity of 220 tons per hour.

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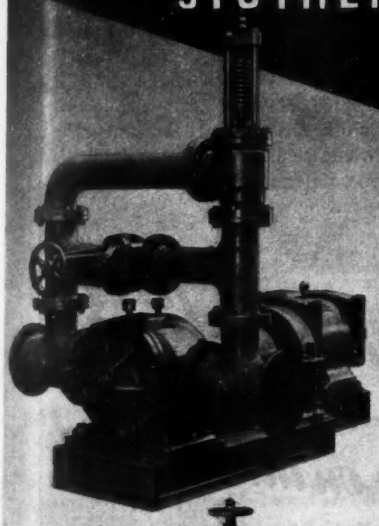
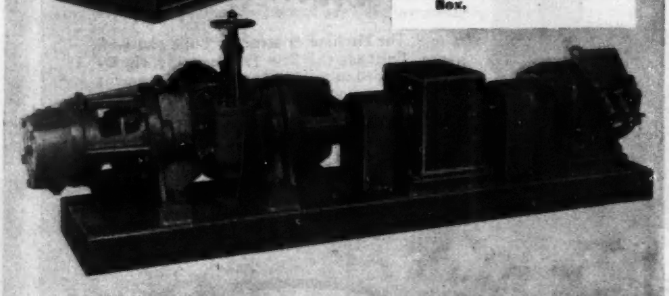


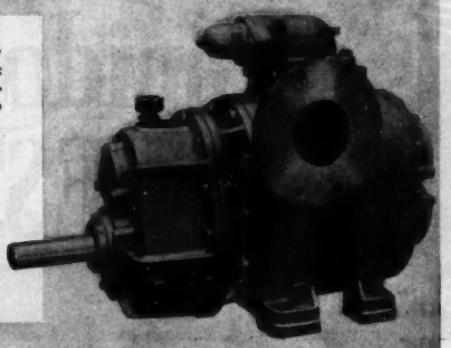
(Left)
Positive Acting Rotary Displacement Pump for the handling of Molasses and viscous fluids, electrically driven through totally enclosed Reduction Gear Box.

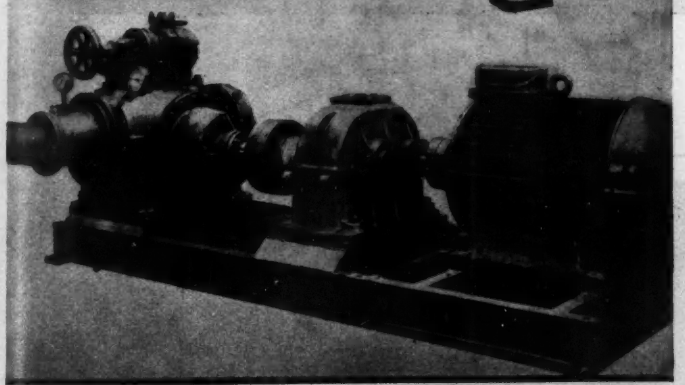
(Below)
Positive Acting Screw Displacement Spirit Pump, electrically driven through Wall Box.



(Right)
Positive Acting Screw Displacement Spirit Pump specially designed for fitting to Road Vehicles.

(Below)
Positive Acting Variable Output Guinard Rotary Piston Pump, electrically driven through Reduction Gear Box, for Oils of varying viscosity.





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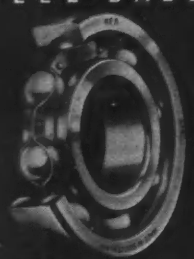

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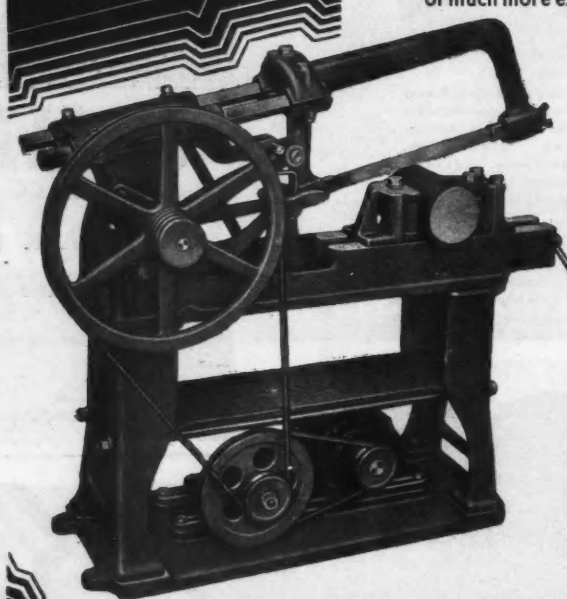

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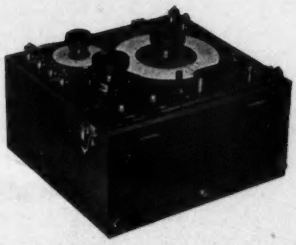

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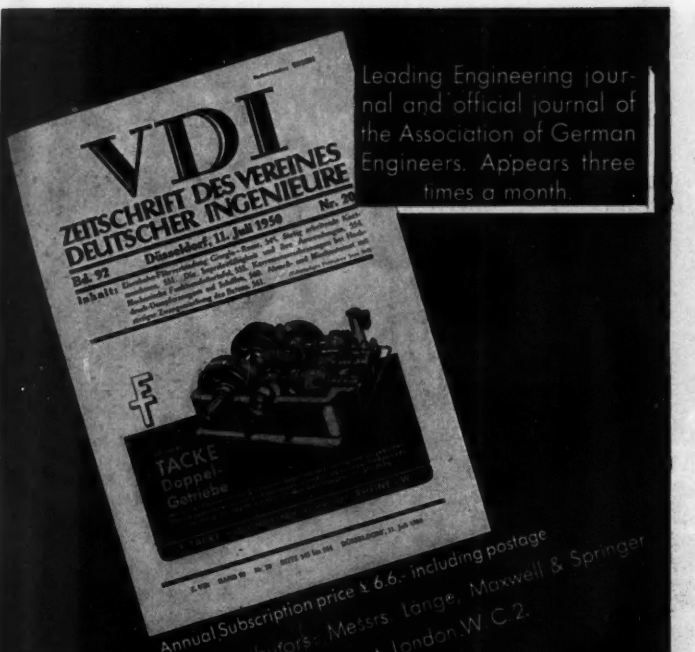

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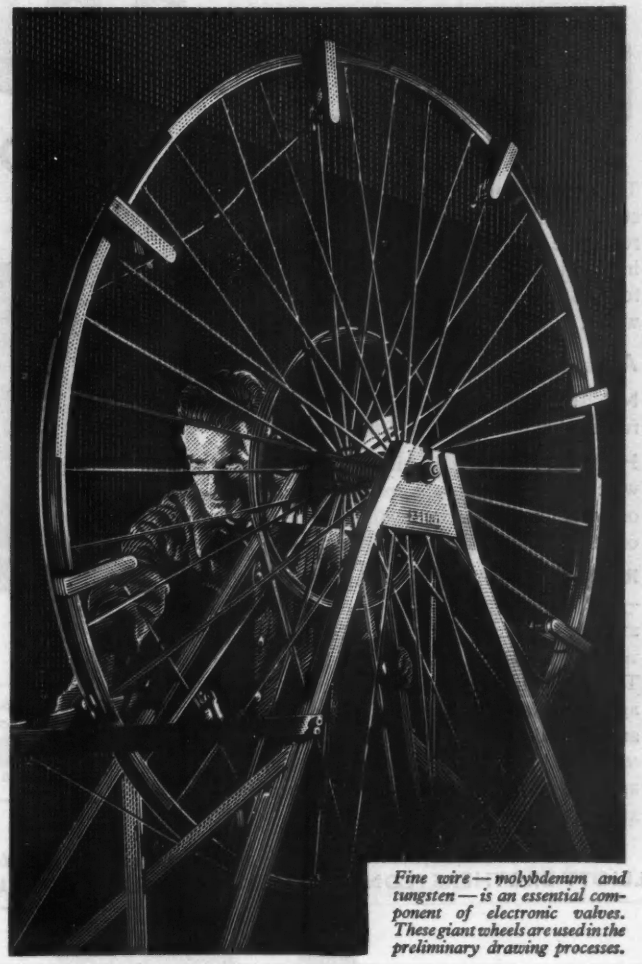

Fine wire — molybdenum and tungsten — is an essential component of electronic valves. These giant wheels are used in the preliminary drawing processes.

PROGRESS IN ELECTRONICS

IN the course of its progress the electronics industry has had a profound influence on many subsidiary industries. Twenty-five years ago, for instance, Britain's annual output of fine molybdenum and tungsten wire was about fifty million yards. Today, this figure represents little more than a month's production in Mullard's own giant plant. These enormous quantities are largely absorbed in the manufacture of Mullard radio valves, television tubes and other electronic devices.

Mullard make this vital raw material themselves in order to control the quality of their products from the earliest stage of manufacture. The factory in which it is produced is one of the most efficient in the world, and the advanced manufacturing methods and the specialised skills employed there are typical of the whole Mullard organisation.

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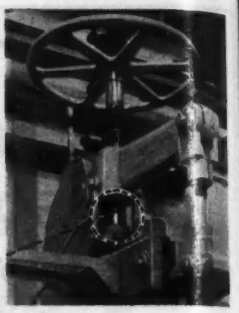

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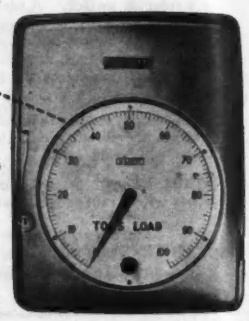

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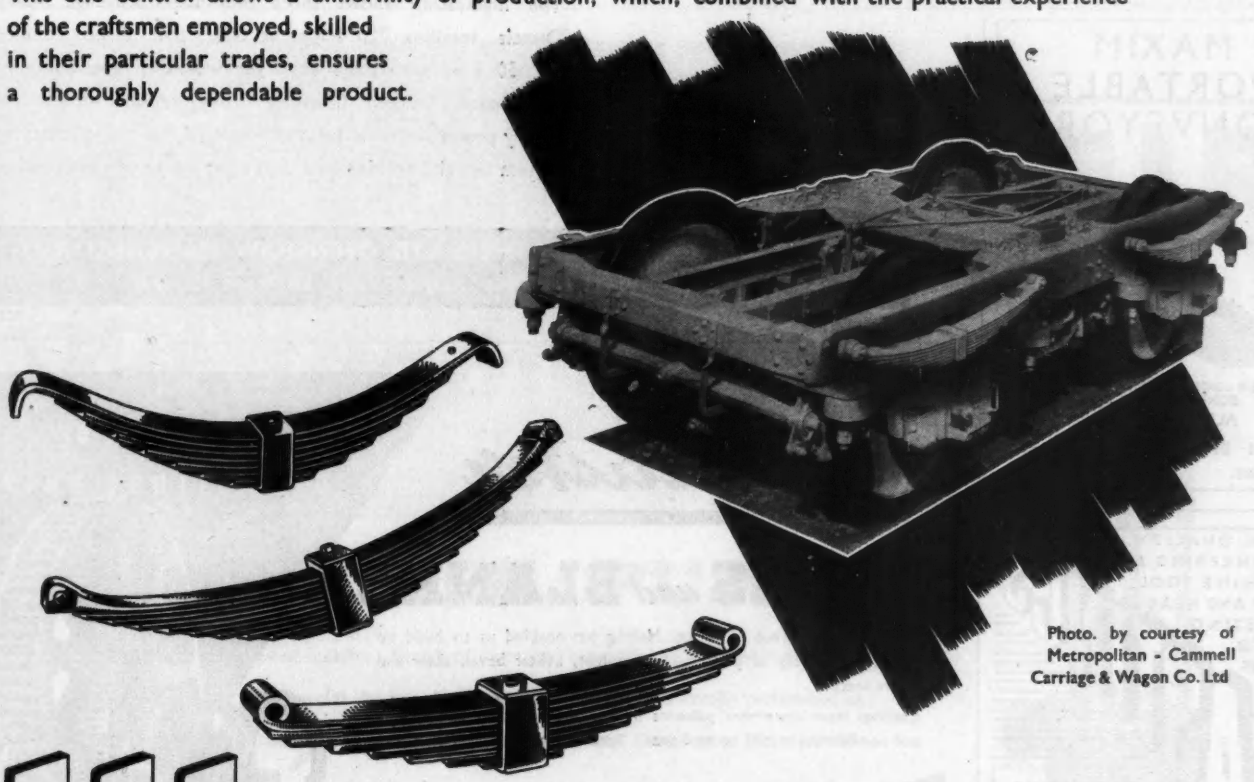

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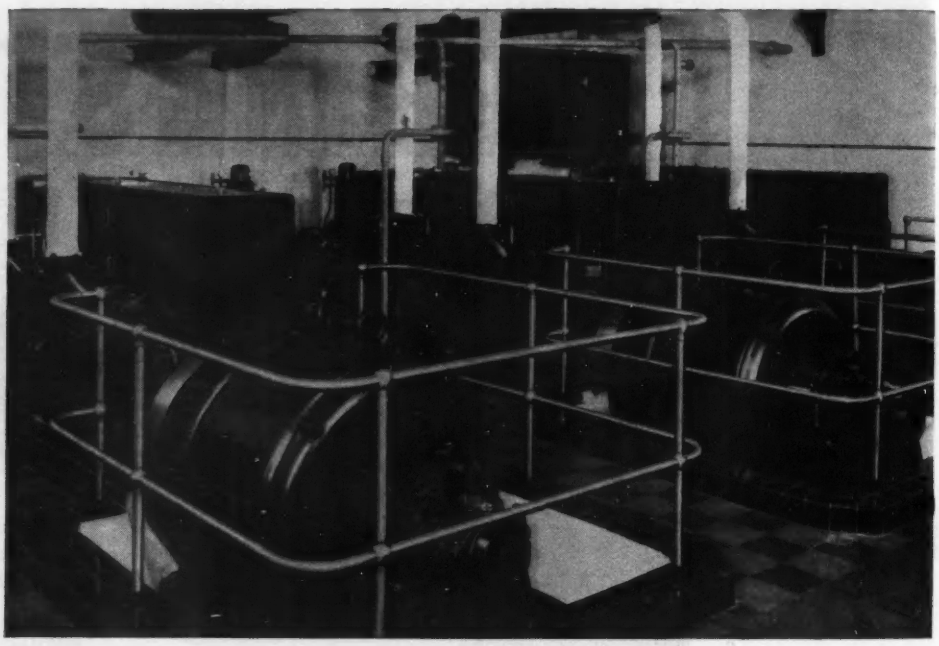

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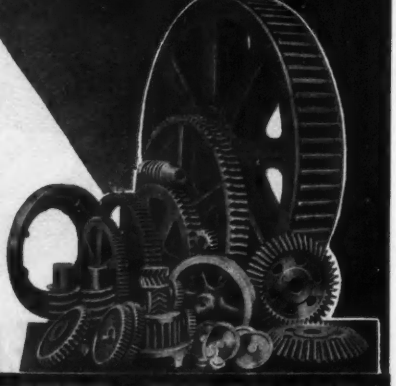

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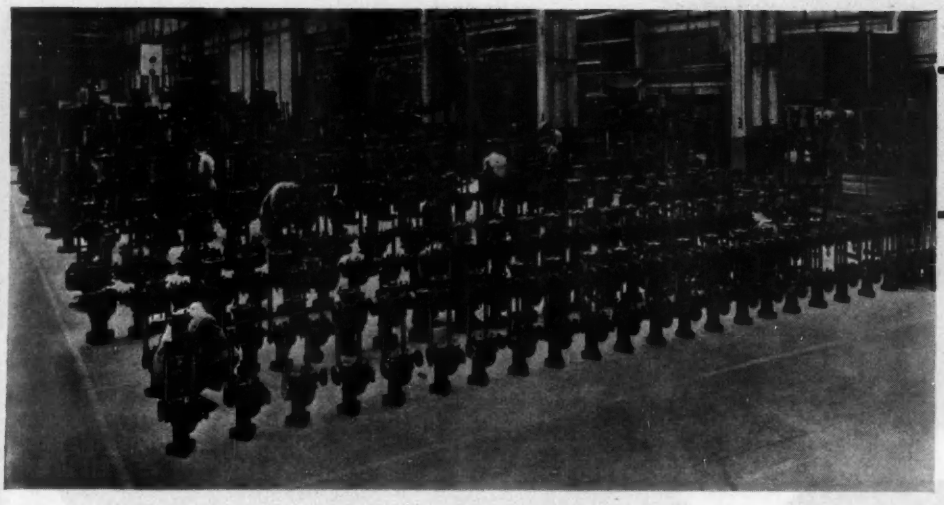

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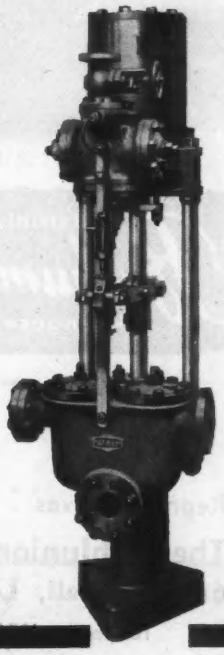

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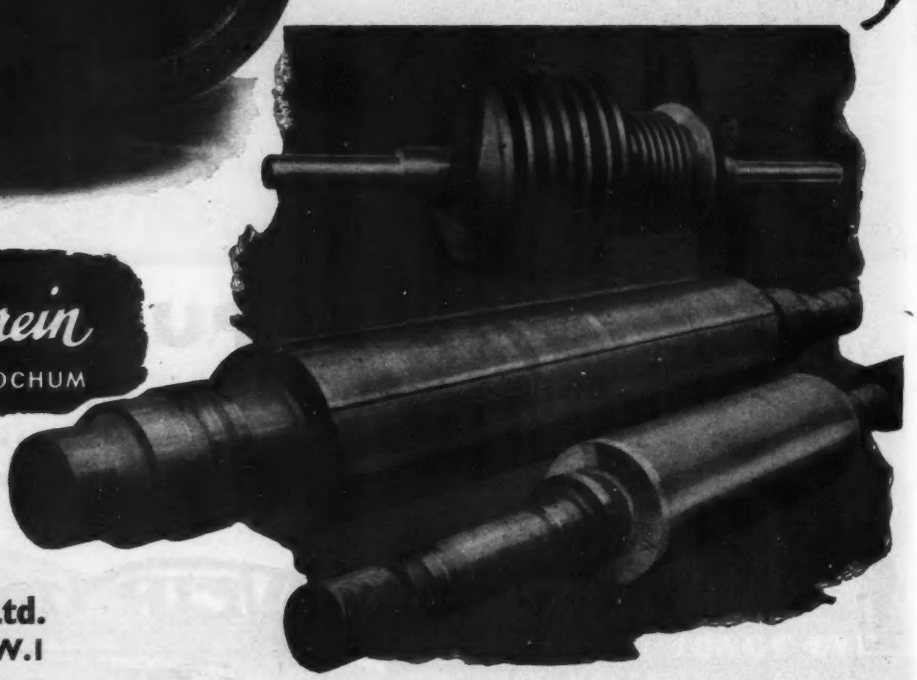

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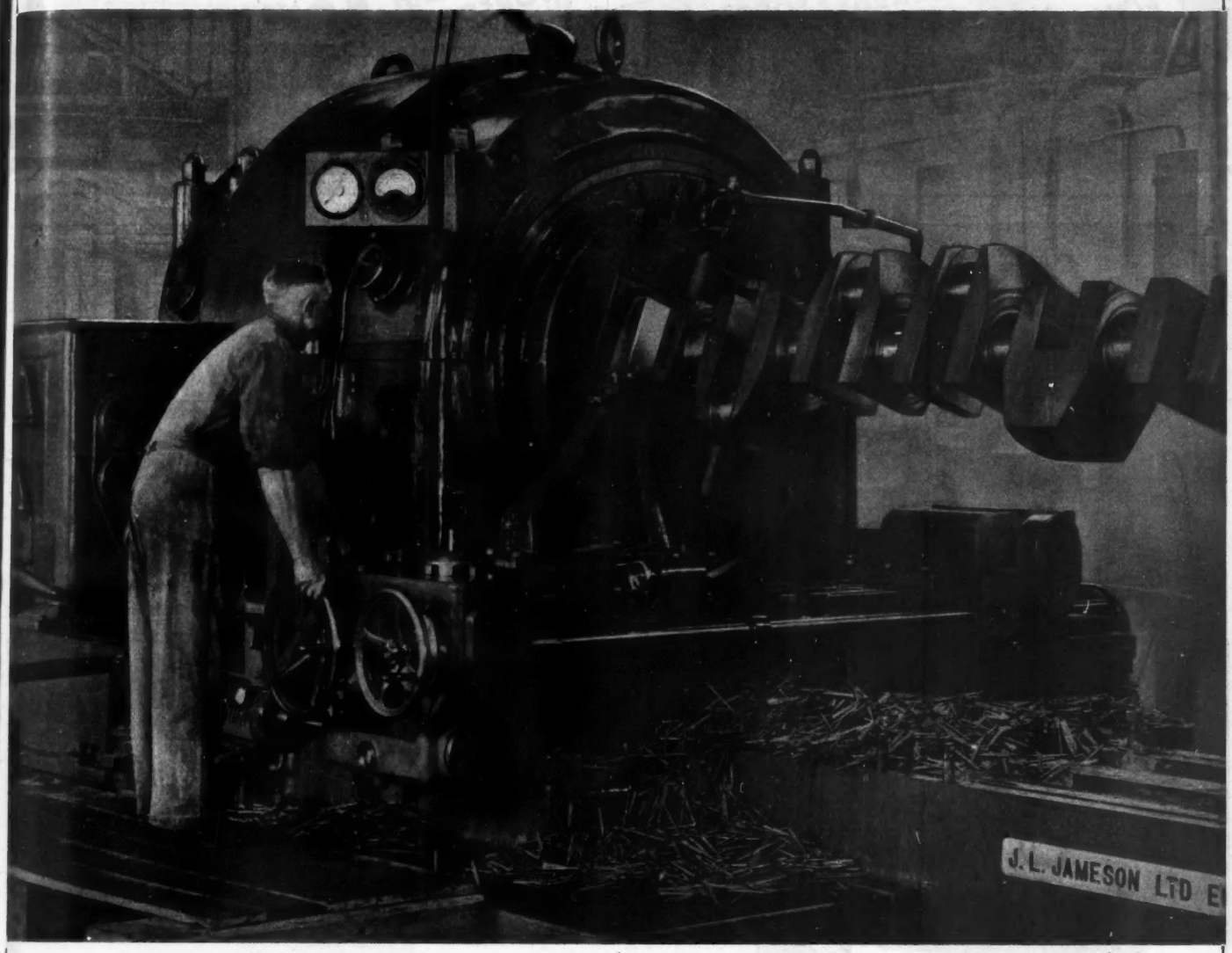

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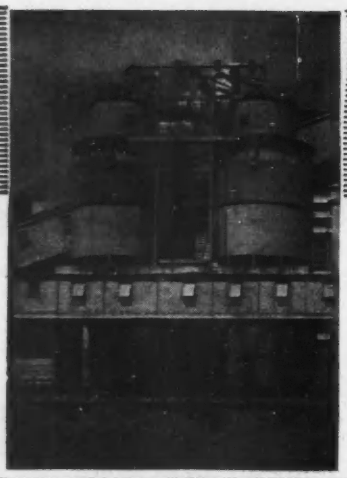

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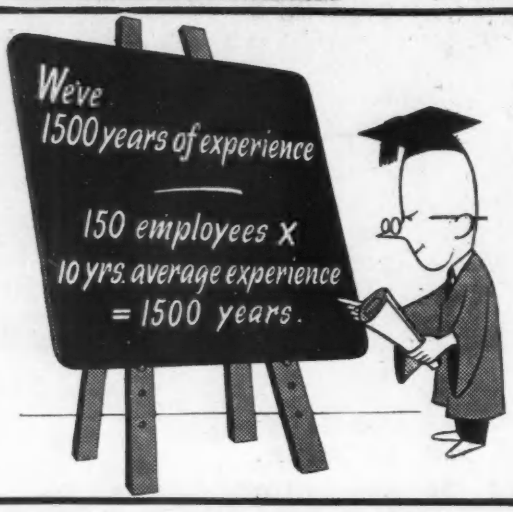

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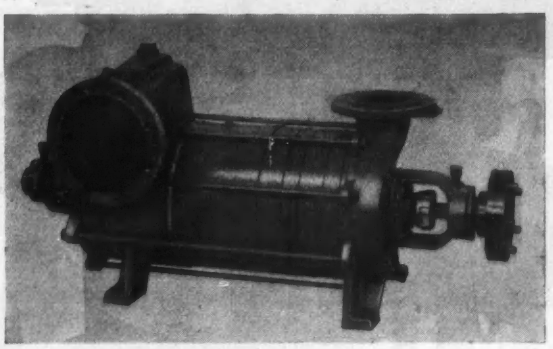

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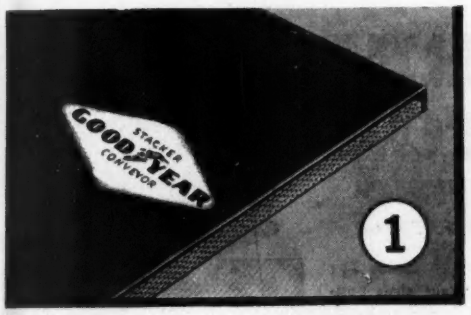

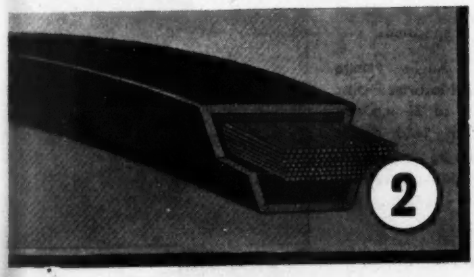

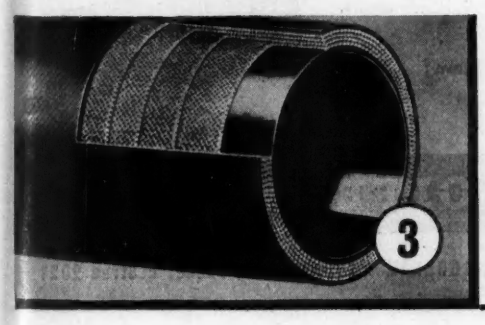

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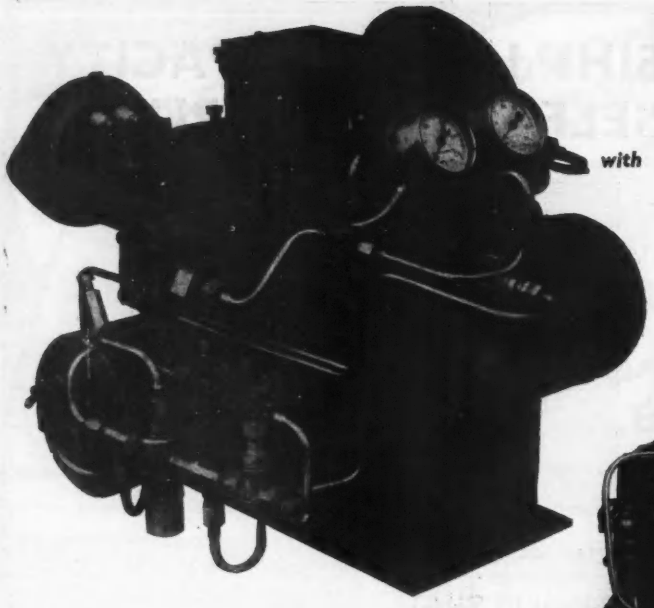

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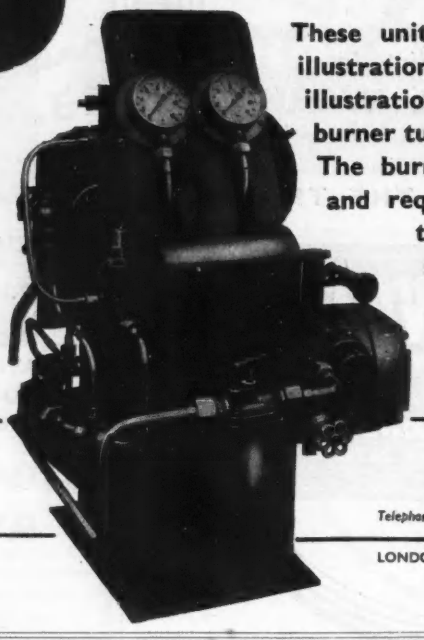
for all grades of fuel oil up to 950 seconds Redwood No. 1 at 100°F., and for capacities up to 800 lb. of oil per hour.



These units can be fully automatic (top illustration) or hand controlled (lower illustration). The latter has an angled burner tube to suit special site conditions. The burners are entirely self-contained and require only an oil pipe line from the storage tank to the pump suction connection.

The burners are described in Section 12 of our catalogue.

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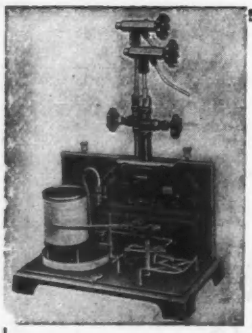

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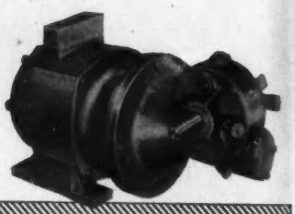
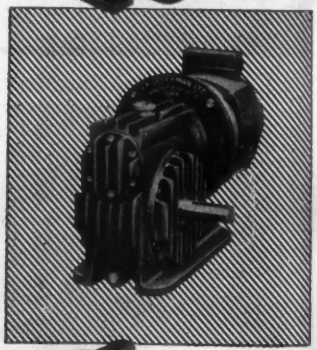
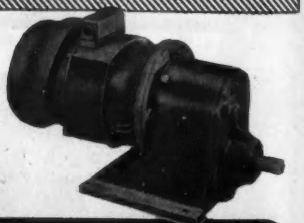


Type GMB2. ¼—1 h.p. Ratios 7½ : 1 up to 50 : 1. Output shaft position as required. Totally enclosed, drip proof, flame proof motors supplied; A.C., D.C., single or three-phase, 110–440 volts as specified.



The G.M.K. Right Angle Flange Mounted Worm Gear Motorised Unit transmits from 1 h.p. to 2½ h.p. on motor input speed of 1420 r.p.m. Ratios fitted range from 5½ : 1 to 60 : 1. Both input and output shafts are mounted on double-purpose ball bearings.



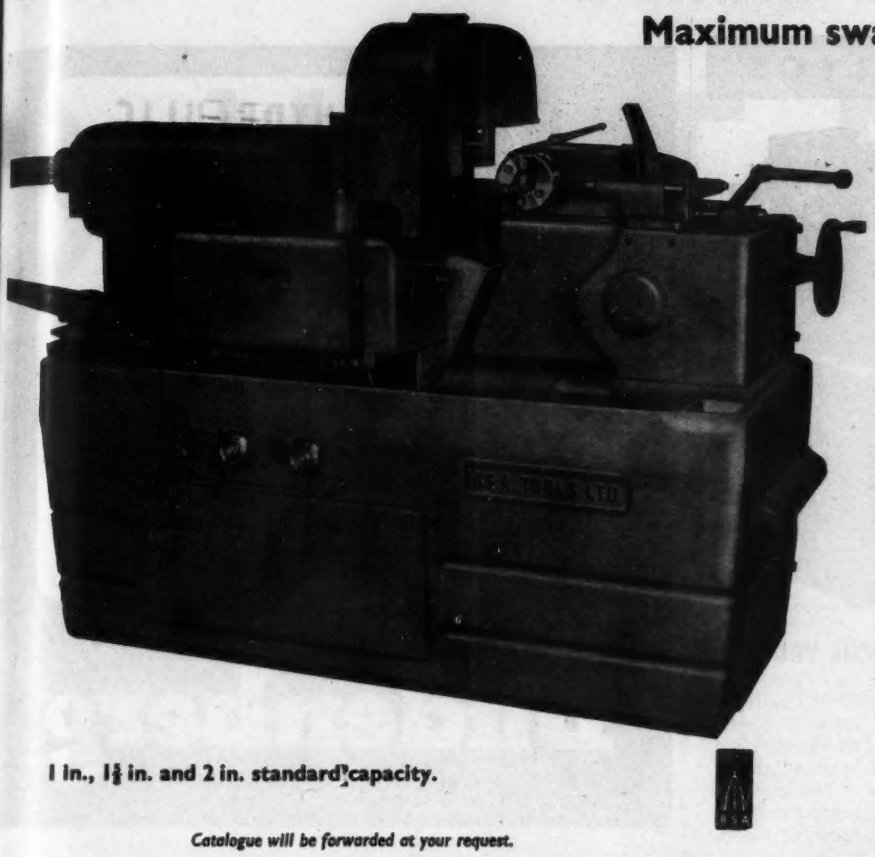
Standard Type. Most ratios, 12 r.p.m. to 700 r.p.m. 1/10 to 1 h.p. A.C. and D.C., single or three-phase motors, 110–440 volts.

Full illustrated details from:

S·E·OPPERMAN LTD

STIRLING CORNER, BOREHAM WOOD, HERTS., Phone: ELStree 2021

Maximum swarf clearance and accessibility



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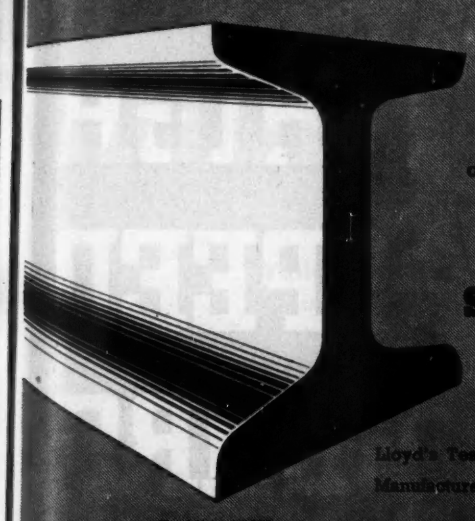

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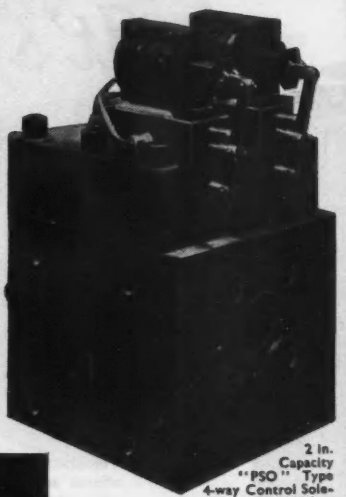

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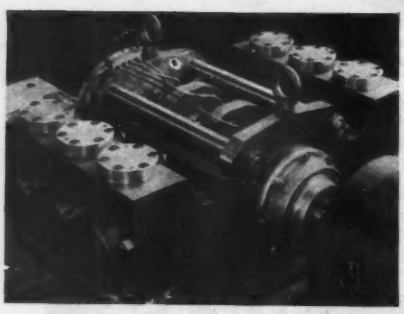

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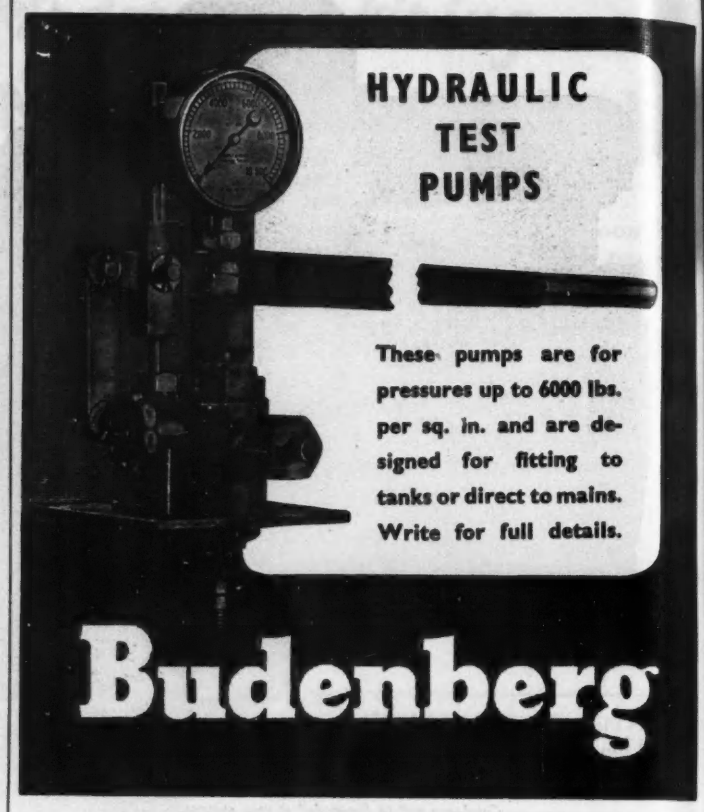

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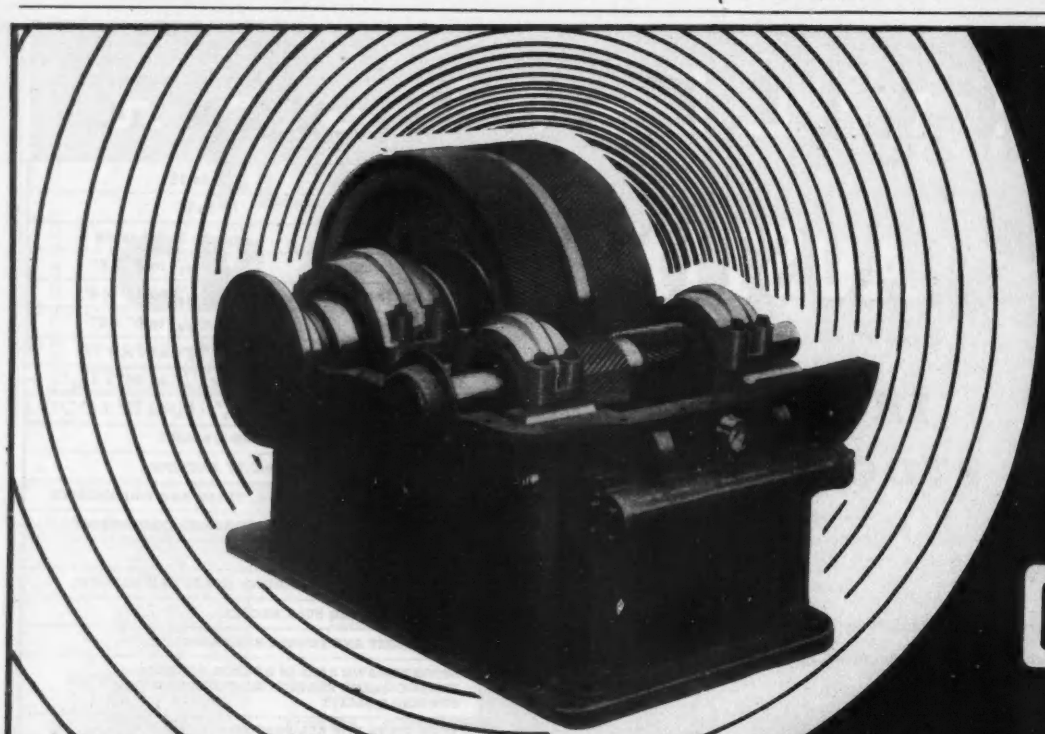

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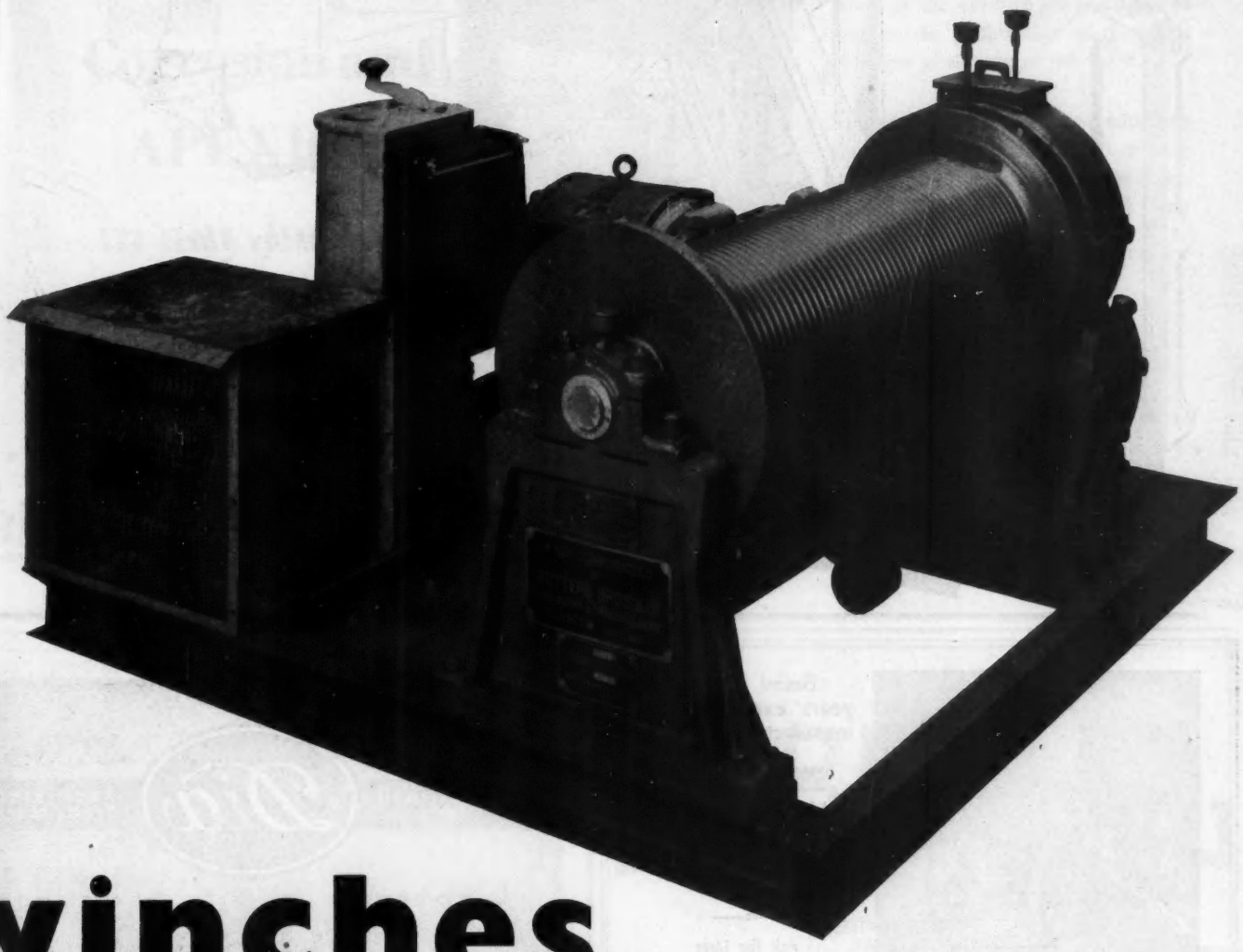

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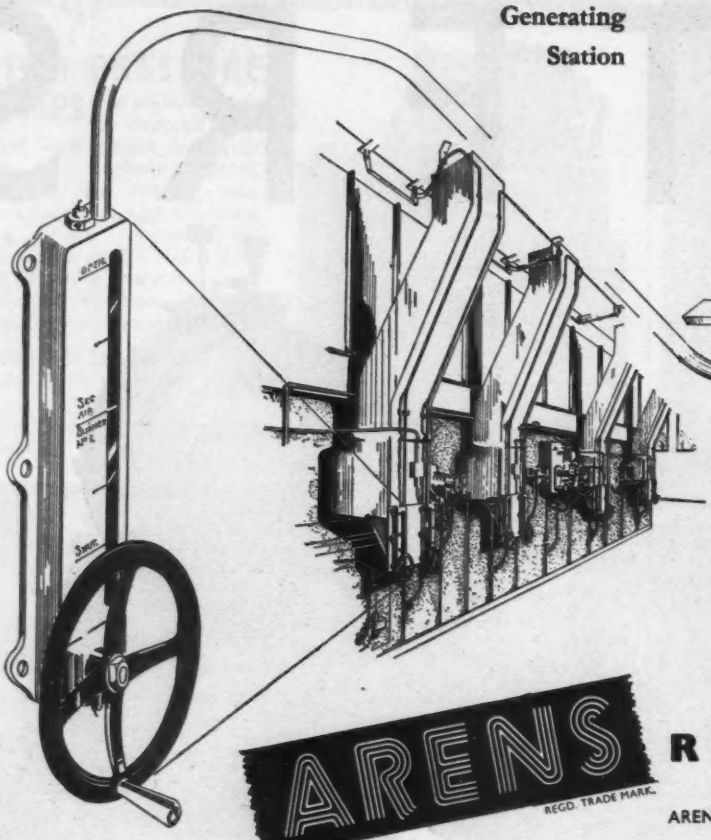

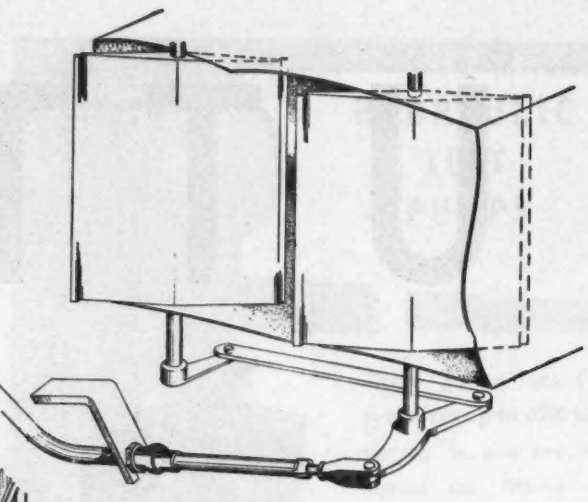

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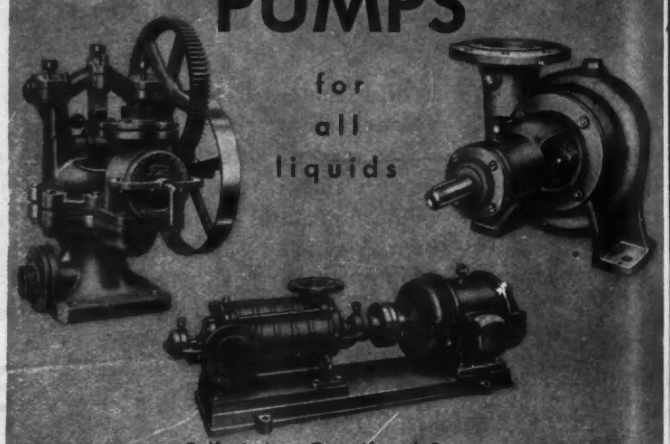

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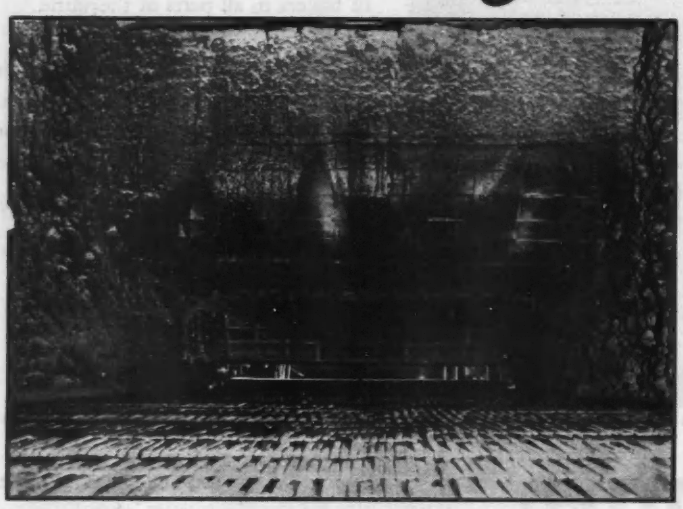

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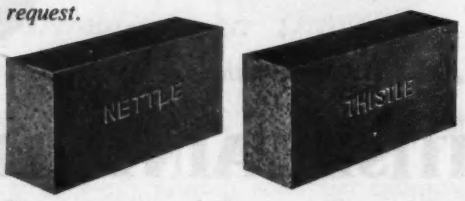

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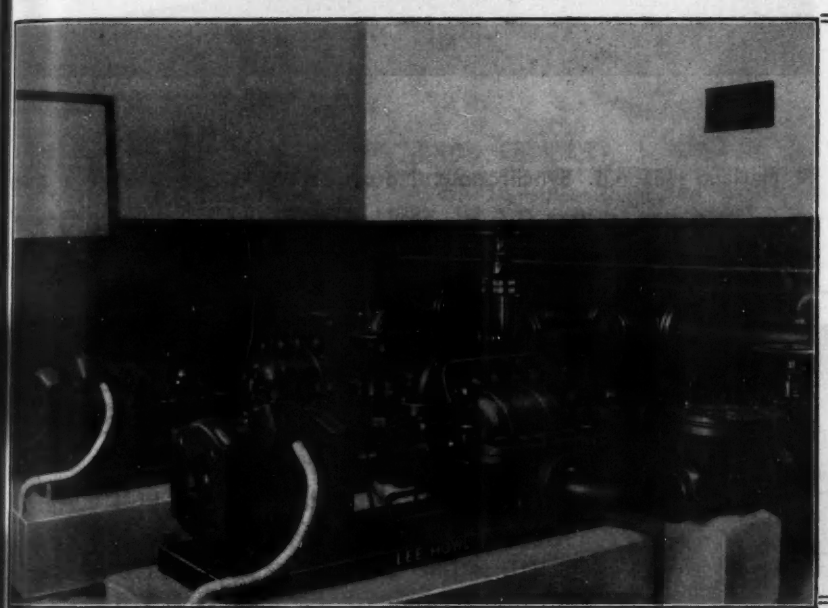

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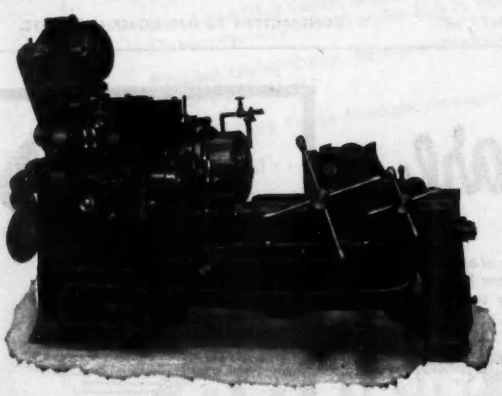
PHOTOGRAPH SHOWS THE AUTOMATIC BOOSTER PUMPING PLANT INSTALLED FOR THE MID-WESSEX WATER COMPANY

Heap's Patent Screwing Machines

with Tangential Dies



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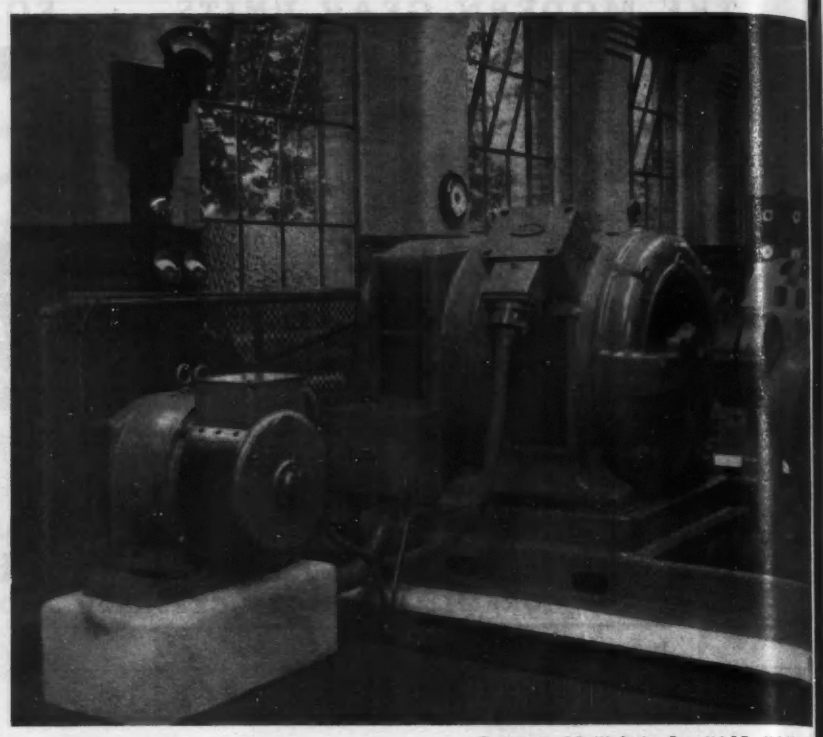
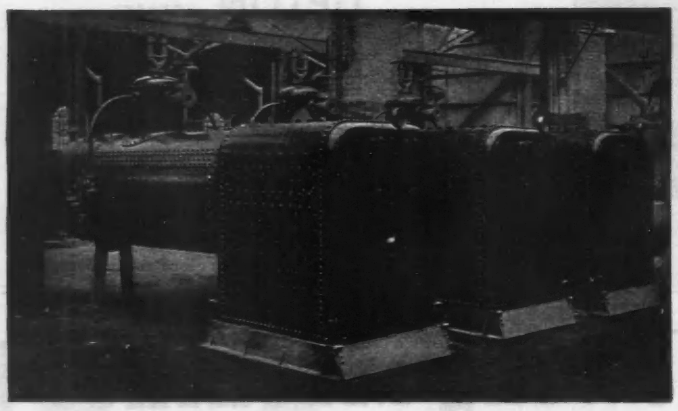


By courtesy of S. W. Davies, Esq., M.I.C.E., M.I.Mech.E., Engineer and General Manager

A Harland 235 h.p. Synchronous Motor driving a pump with a duty of 1,735 g.p.m. against 310 ft. head at 1,000 r.p.m. in the City of Nottingham Waterworks Station at Burton Joyce.



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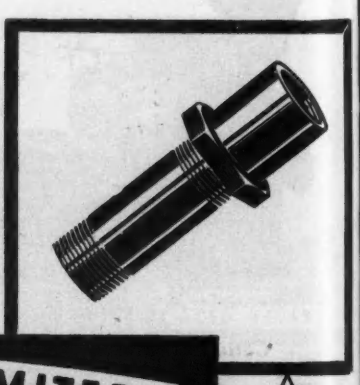

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Flanged Gland Cocks, Straight-through and Three-way.

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Sizes ¼" to 3".

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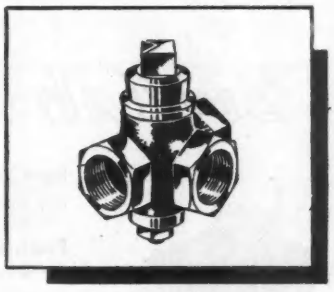

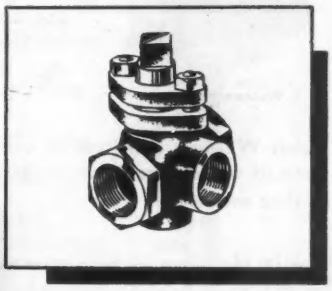

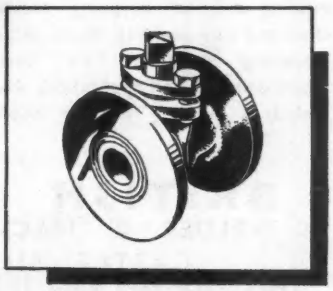

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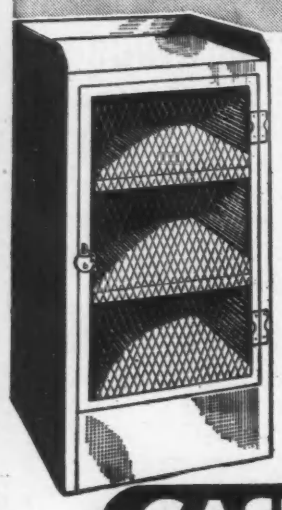

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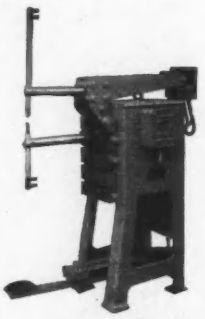

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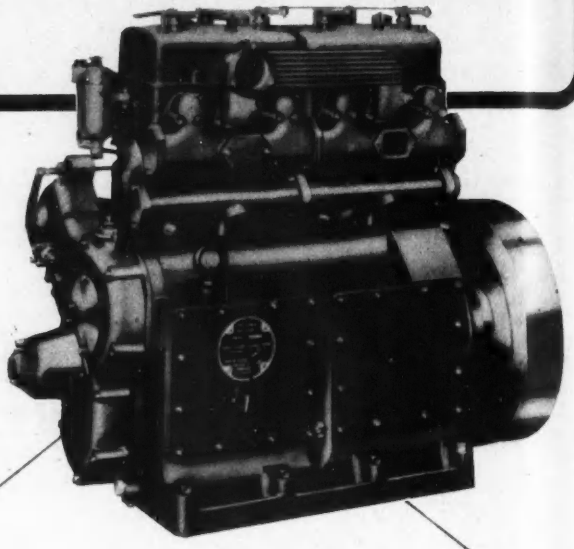

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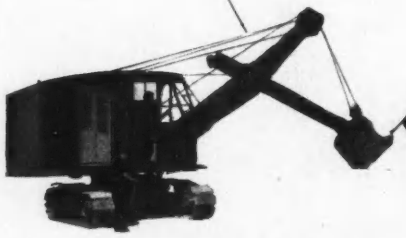

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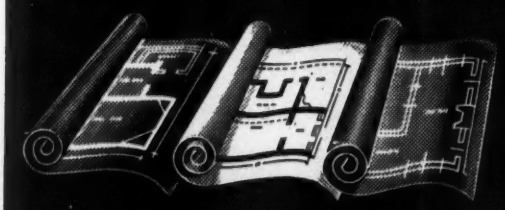

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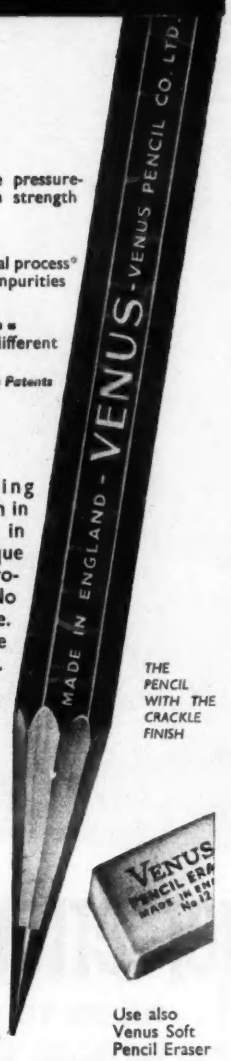

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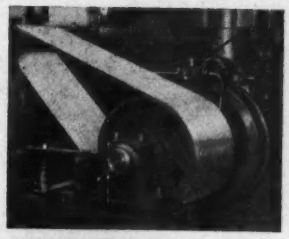

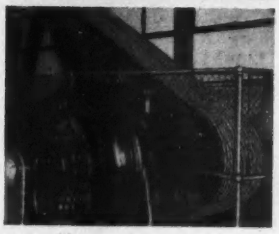

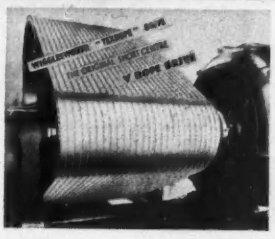

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Electric Chainlift Hoist-block

is an ideal machine for powerlifting in factory, mill, foundry or repair shop, and for saving man-hours every day.

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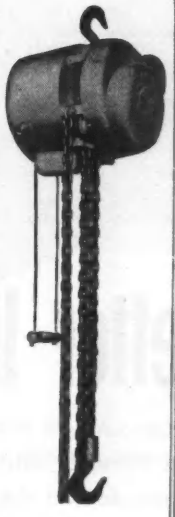
CL49 B	¾	16	1'-11"	81-0-0	"
CL49 C	1	10	2'-7½"	87-0-0	"
CL49 D	1½	8	2'-7½"	98-0-0	"
CL49 E	½	16	1'-11"	75-0-0	2 Phase A.C. 3 or 4 wire
CL49 F	1	8	2'-7½"	87-0-0	"
CL49 G	½	16	1'-11"	92-0-0	Single Phase A.C.
CL49 H	1	8	2'-7½"	104-0-0	"



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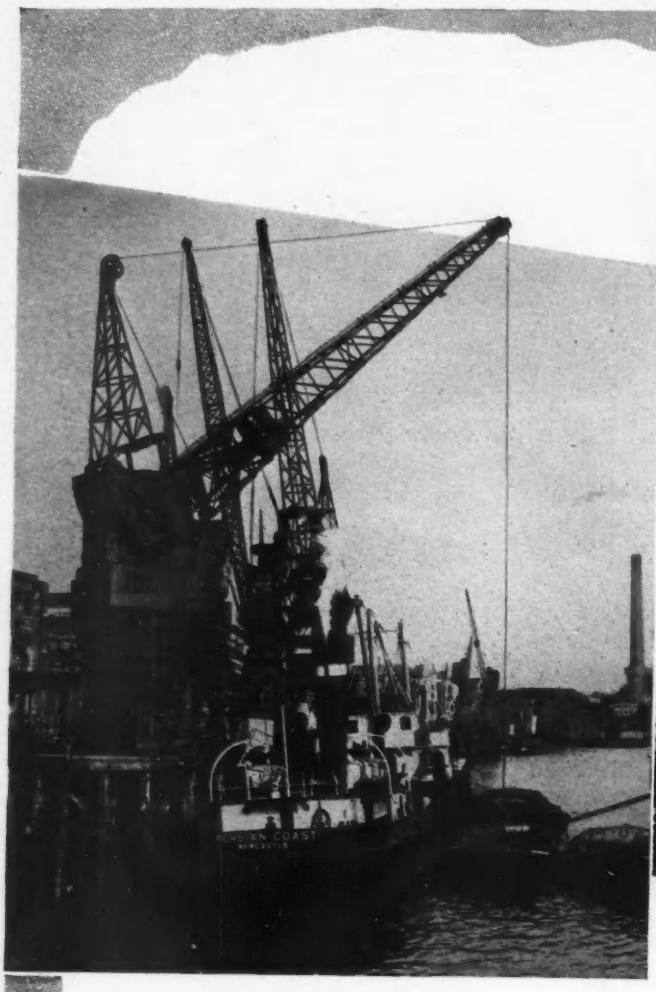
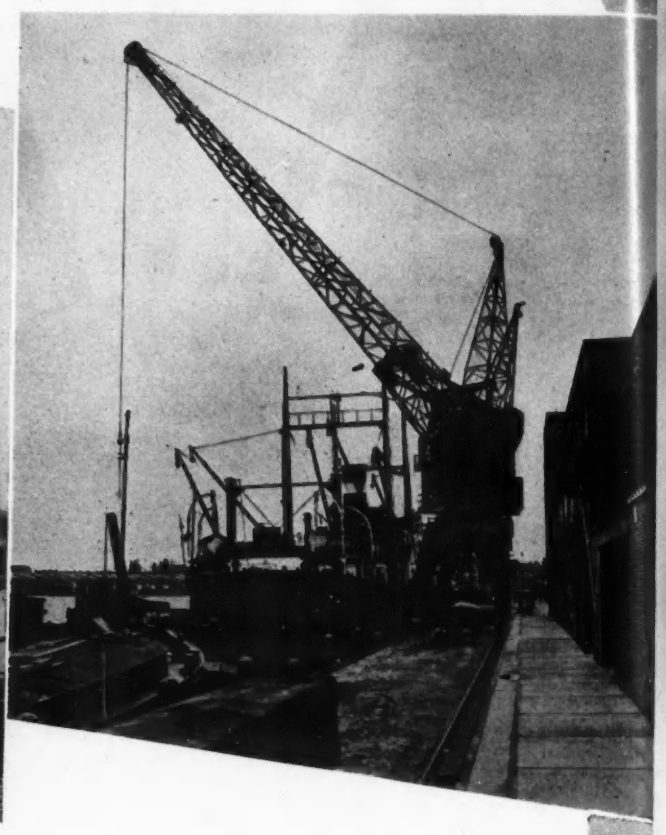
AN ASSOCIATE COMPANY OF THE GENERAL ELECTRIC CO. LTD. OF ENGLAND





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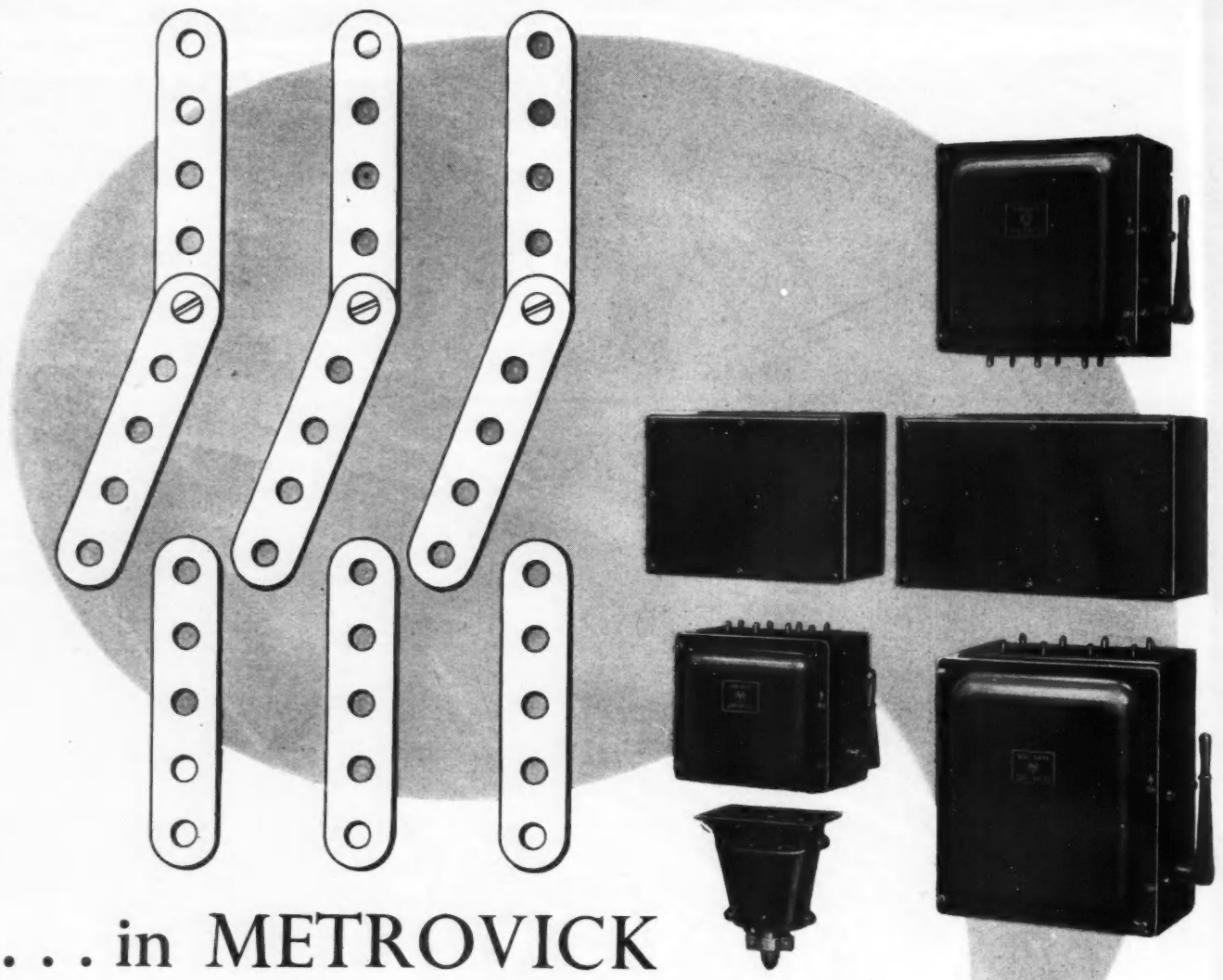

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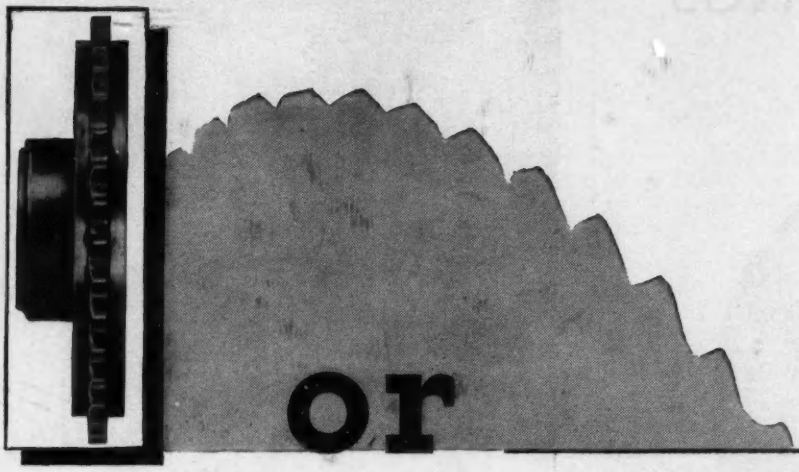

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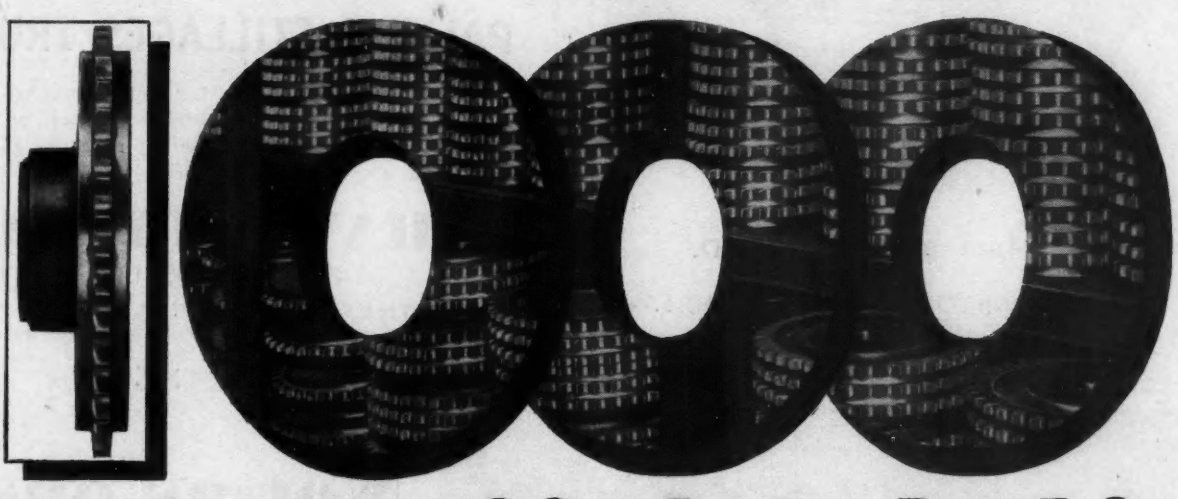

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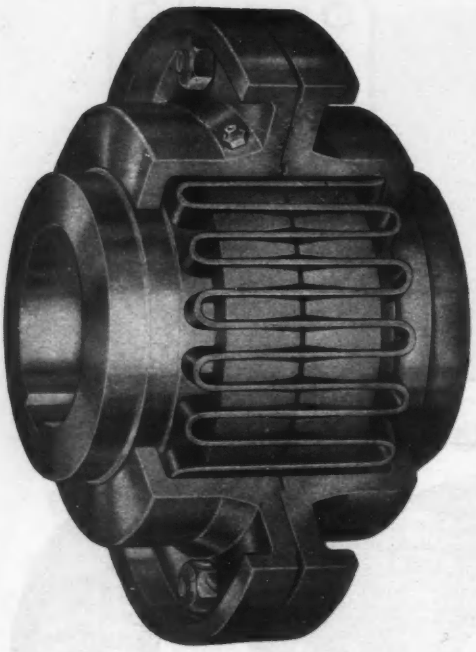

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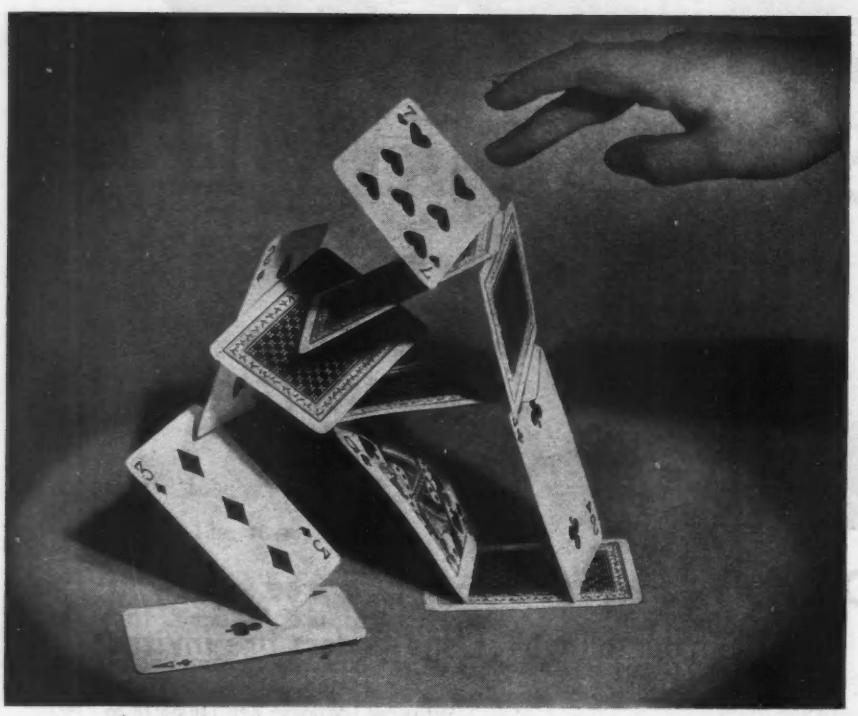

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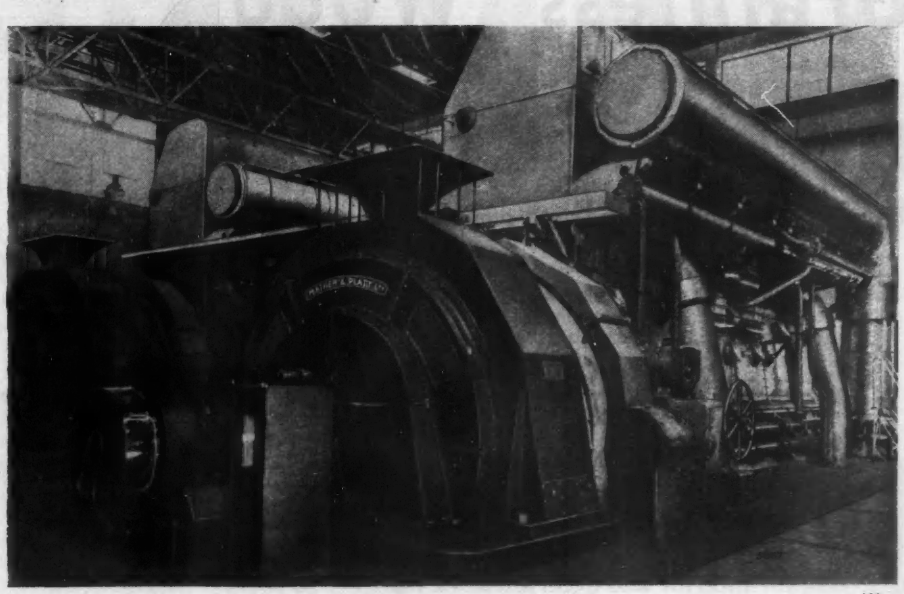

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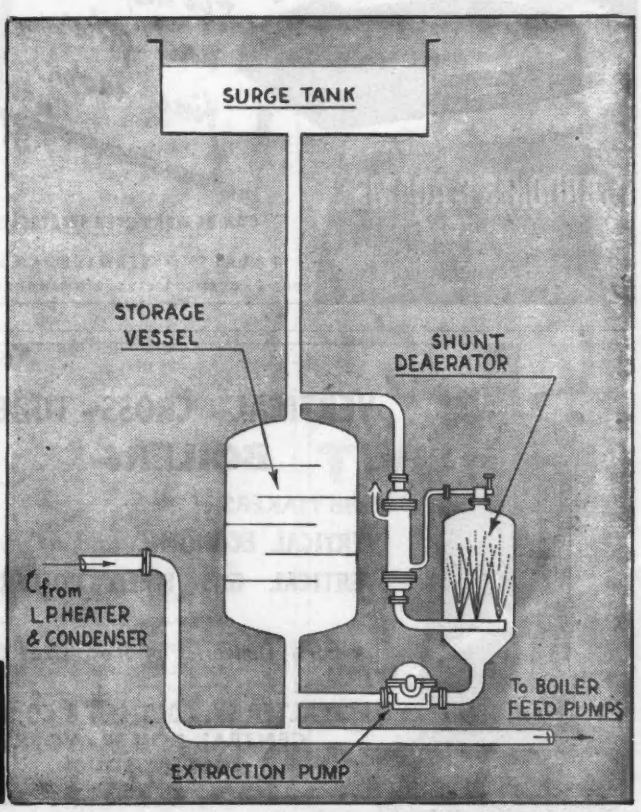

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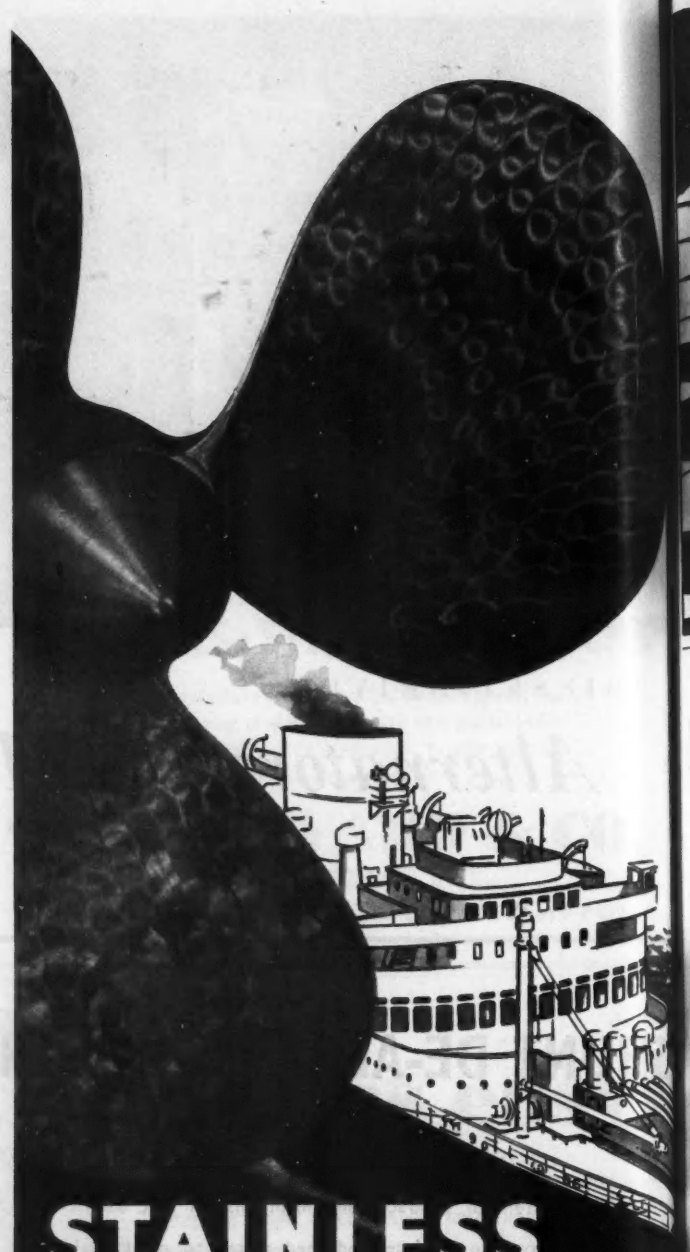

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YOU CAN *DEPEND* ON

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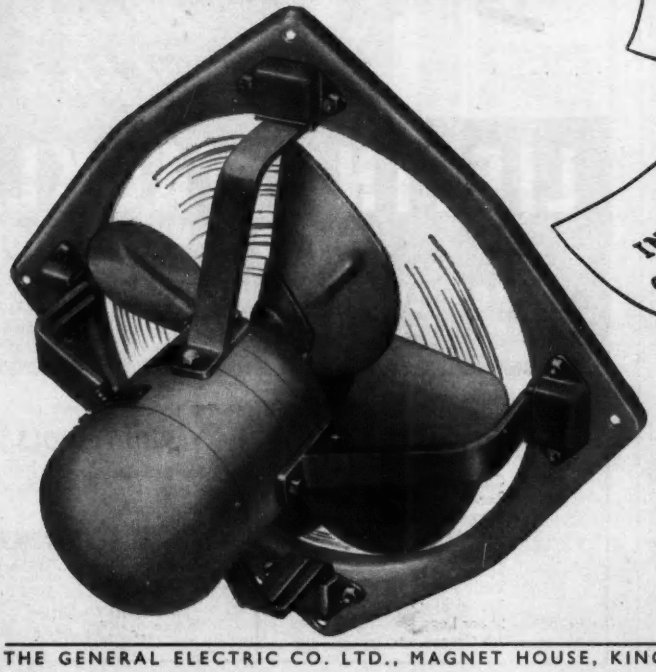

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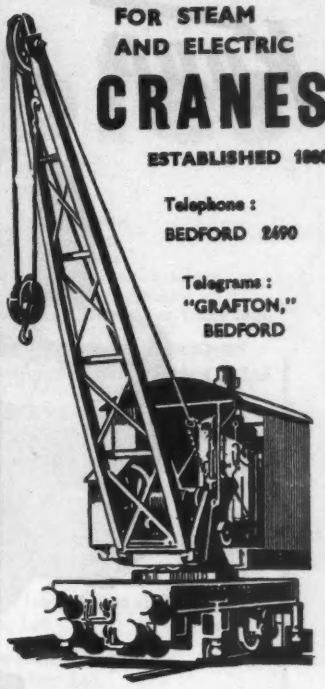

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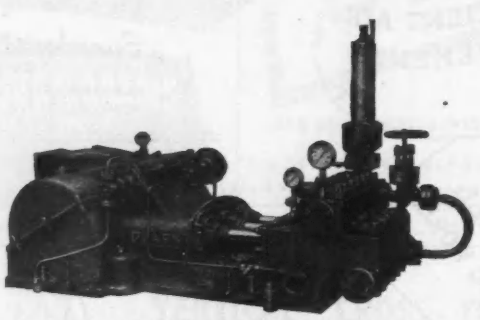

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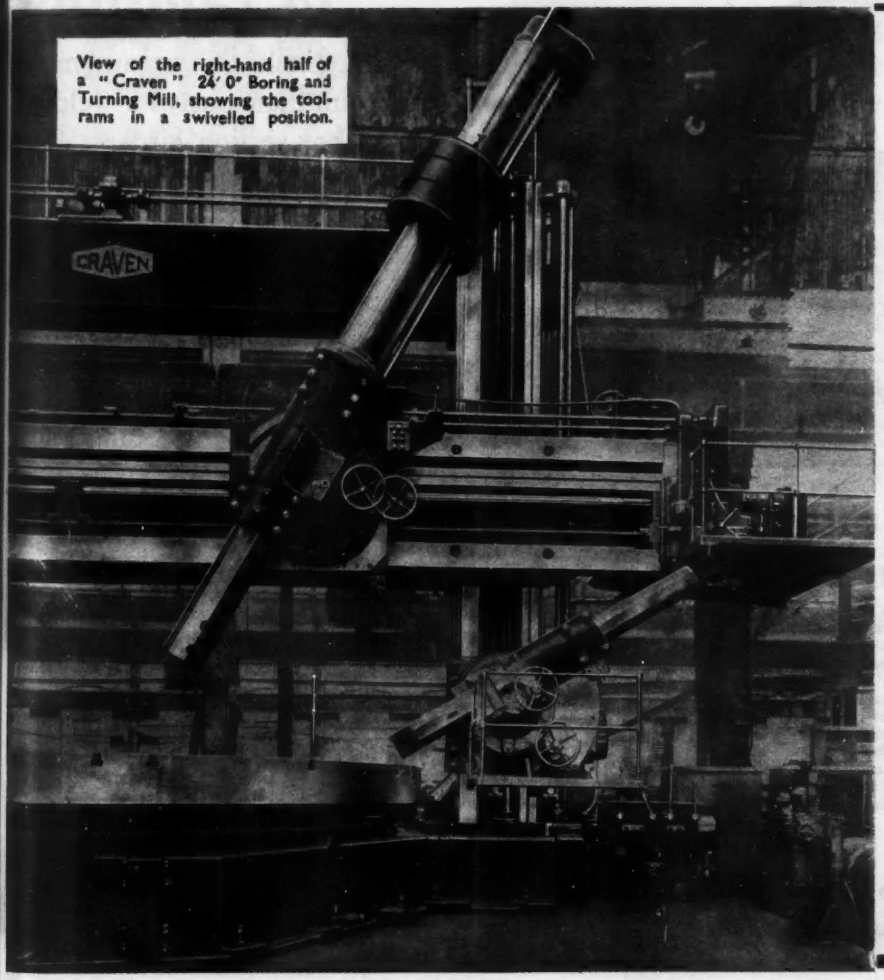

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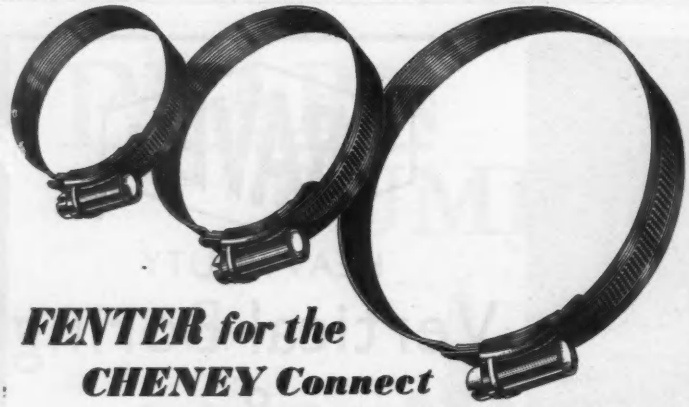

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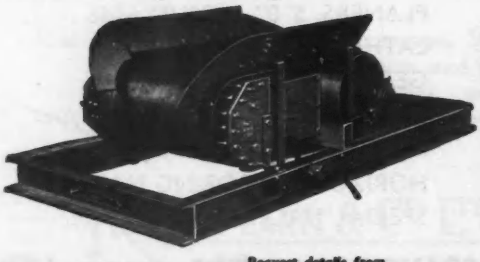

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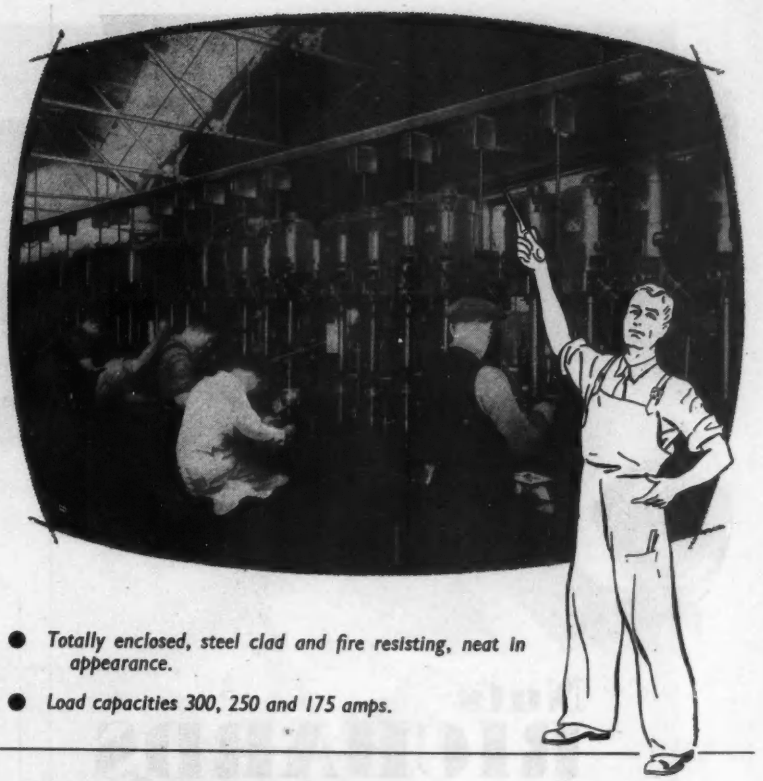

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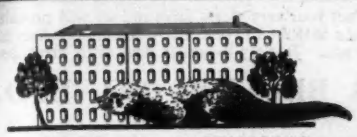

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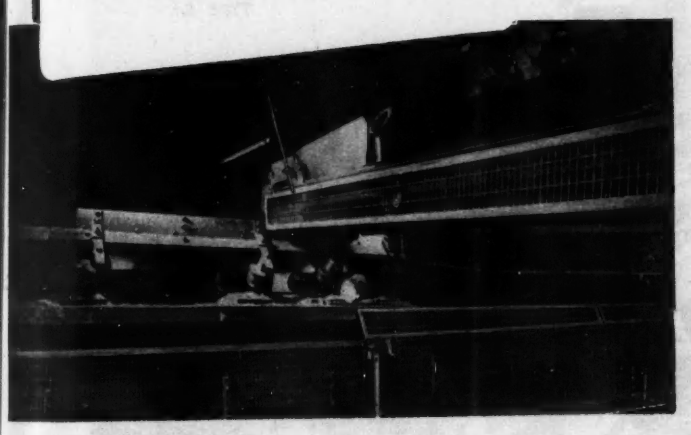

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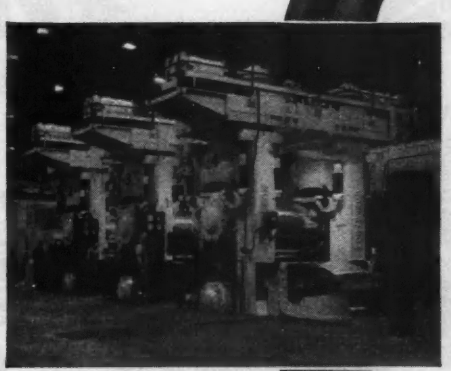

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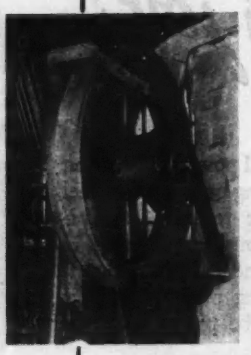

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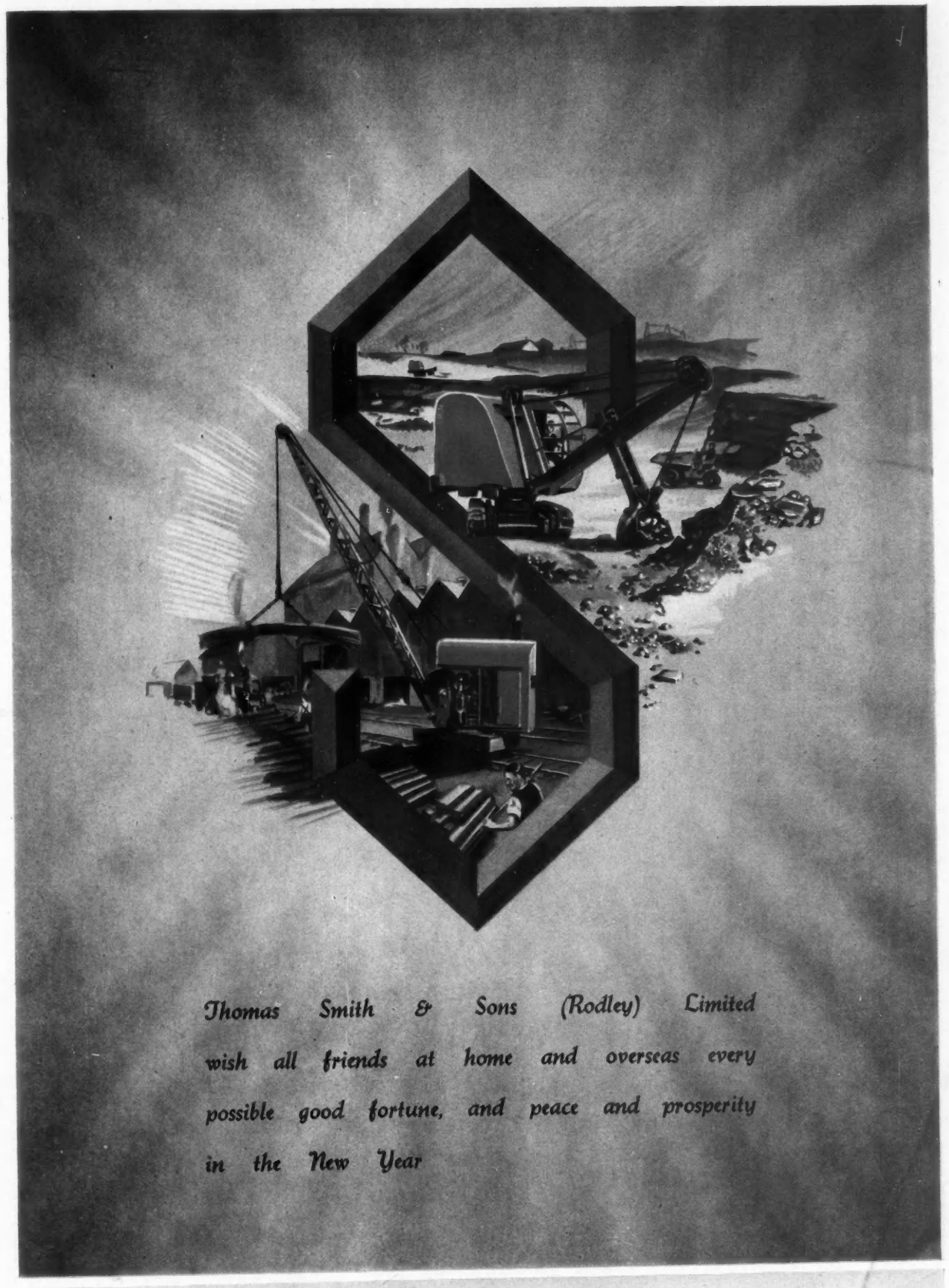

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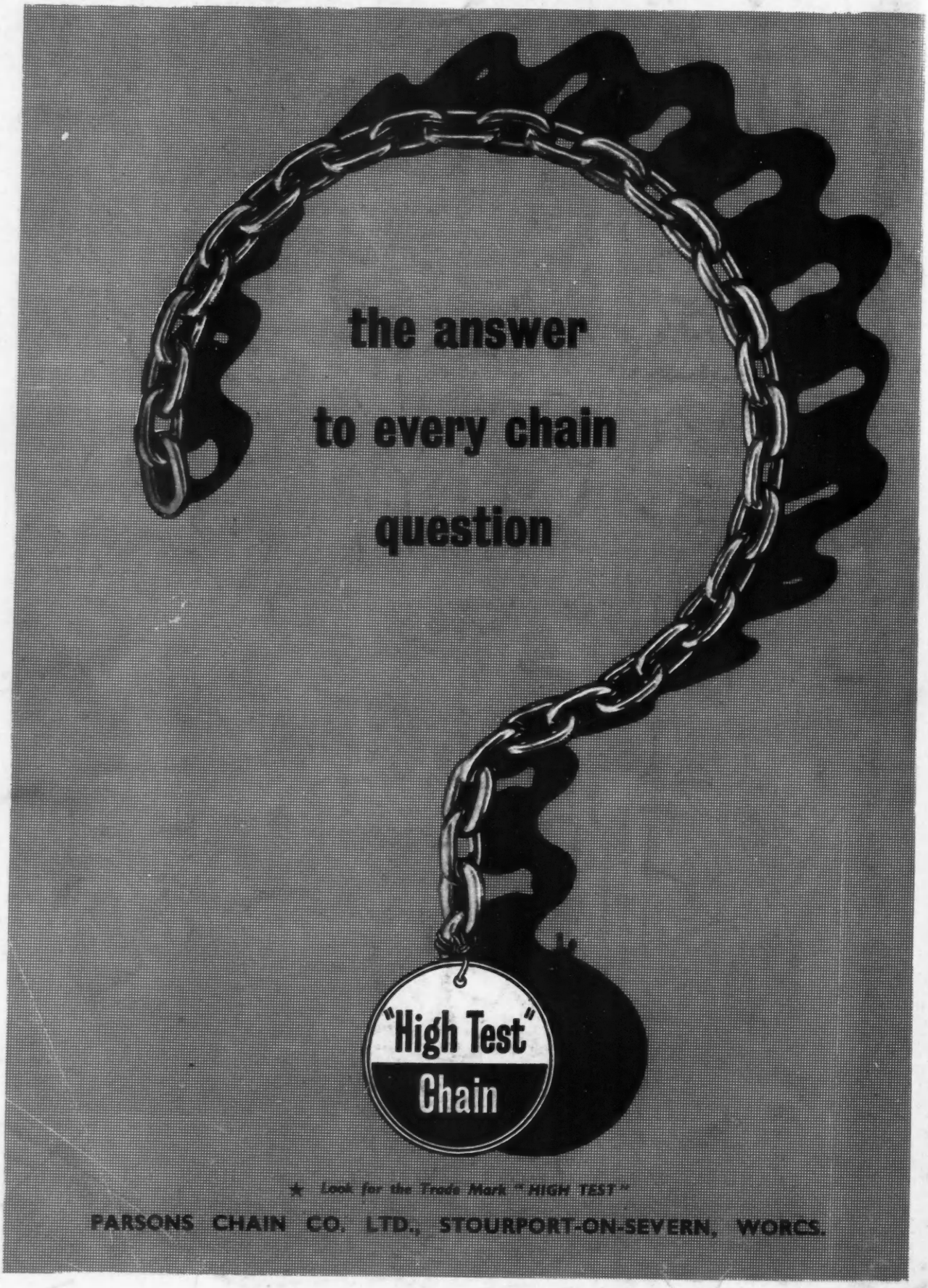
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